SCIENCE

26 May 1961

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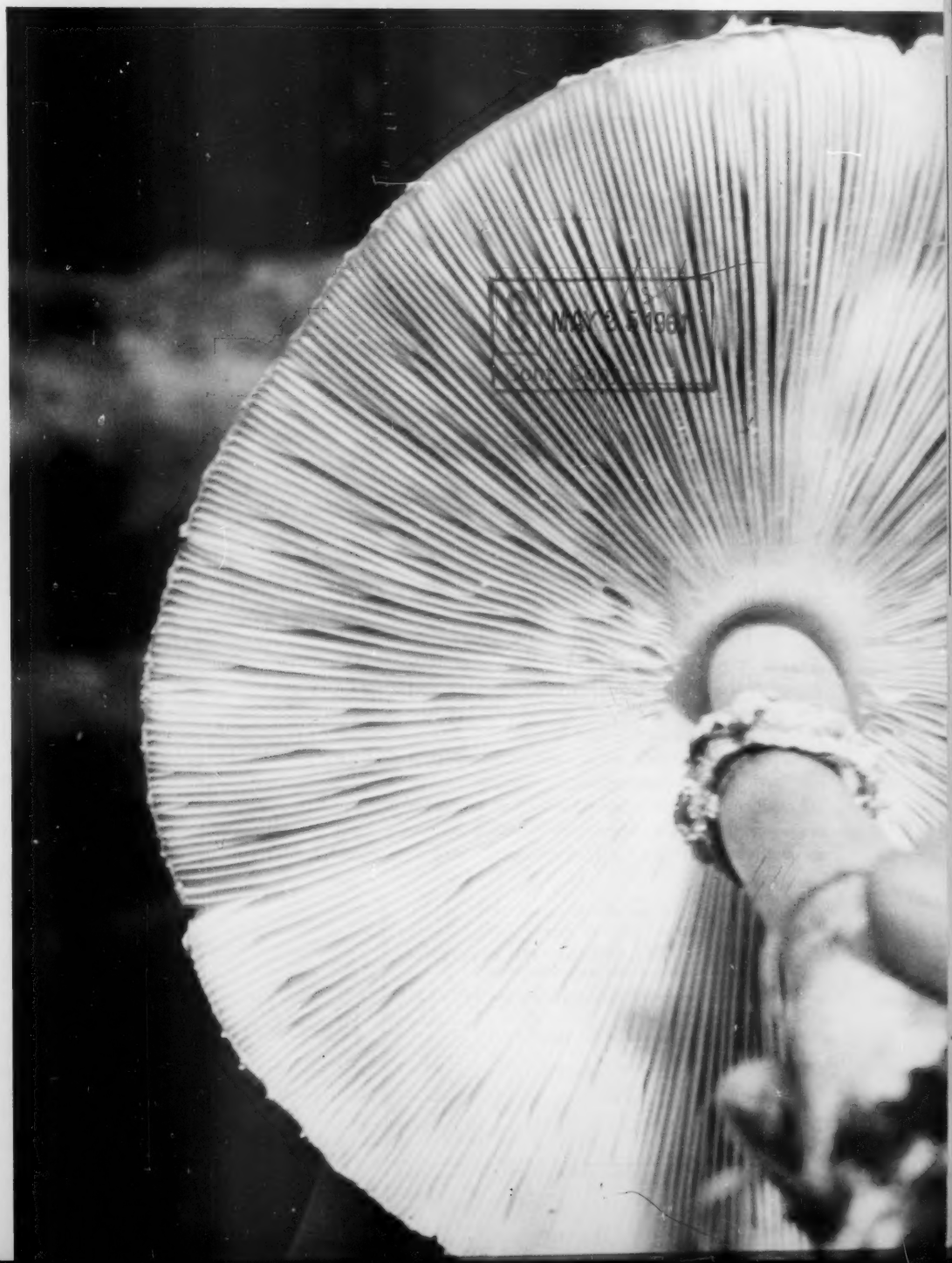
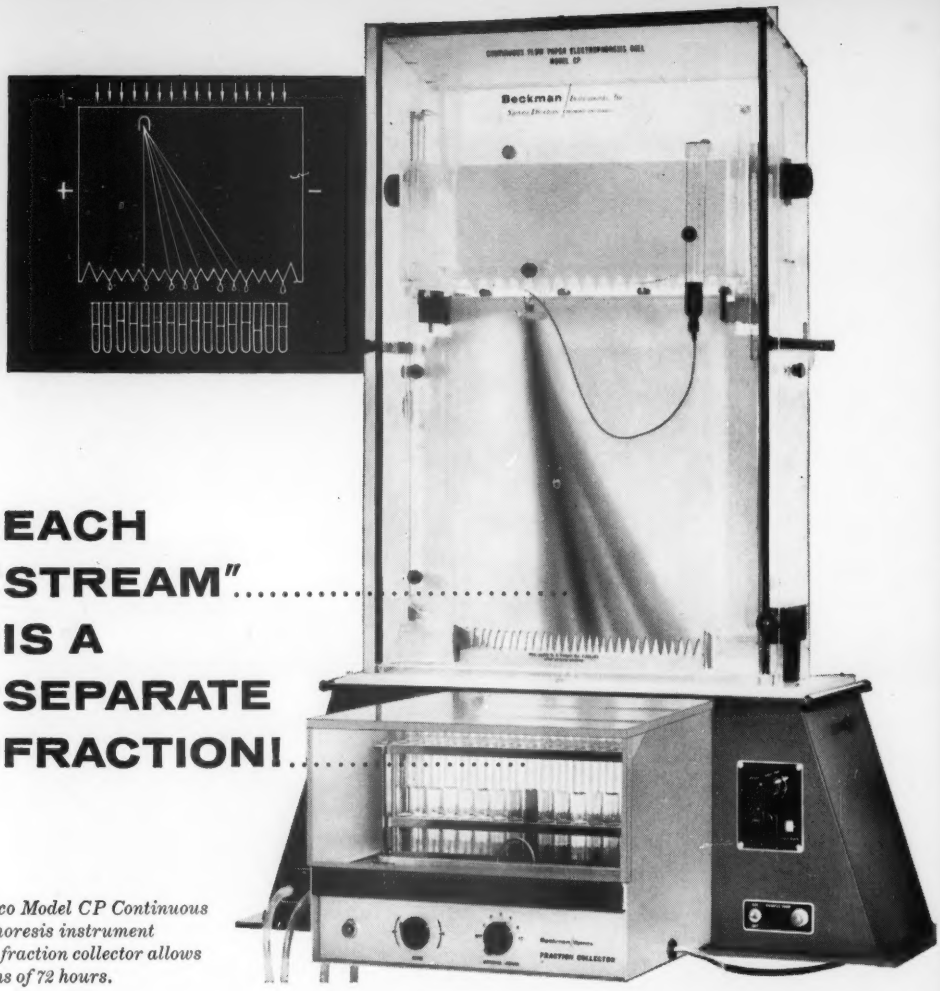
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





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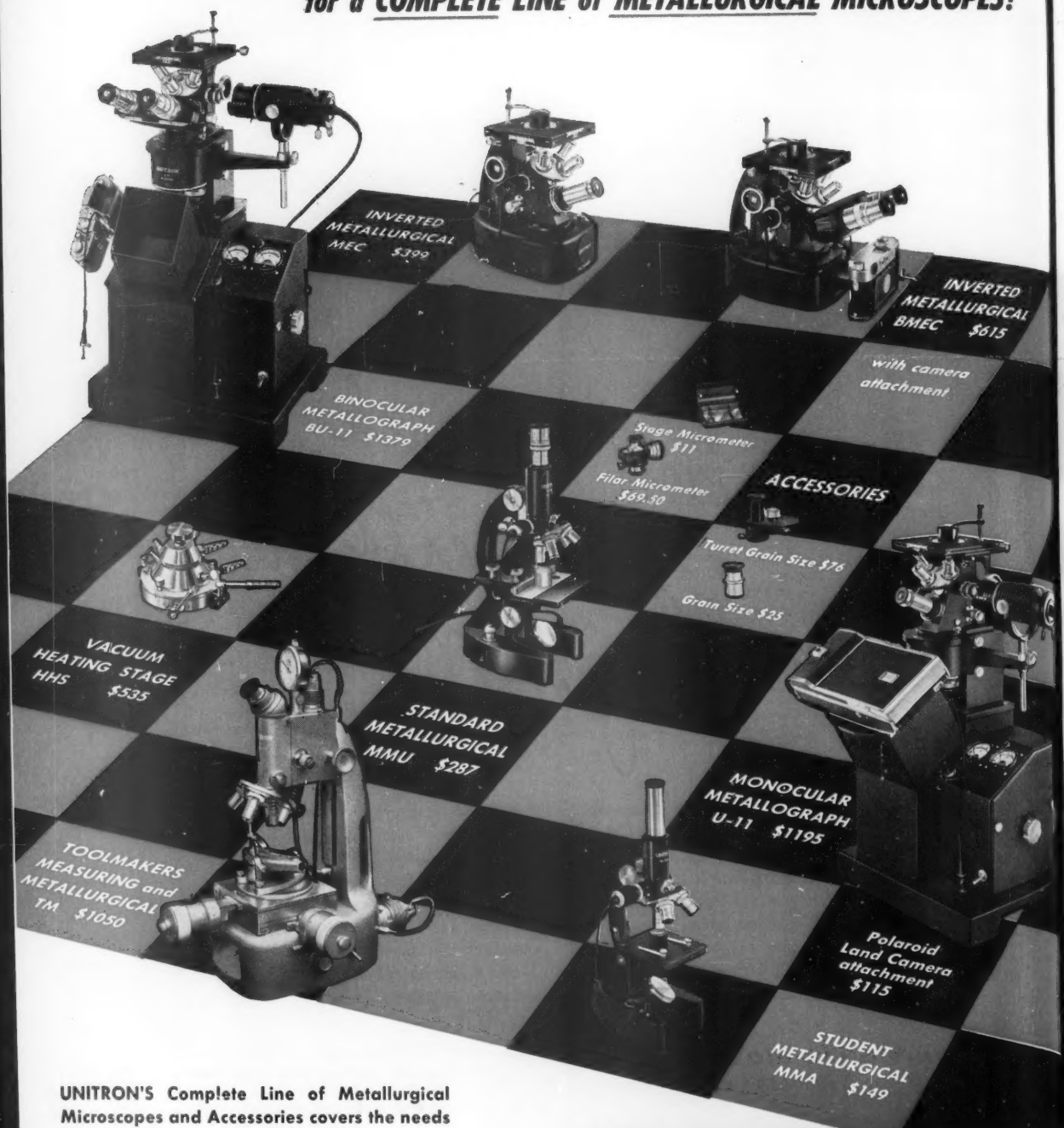

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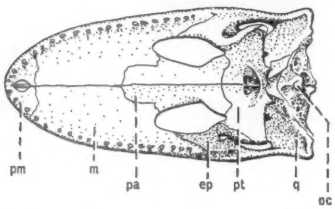
Cover

Common parasol mushroom, *Lepiota procera*, showing the architectural beauty of its lower surface; crowded knife blade gills of white support the umbrella-shaped pileus and bear spores. Gills mark the fungus as a member of the family Agaricaceae. [A. Nettleship, Antaeus Lineal Medical Research Group, Fayetteville, Ark.]

4 Saunders books for science courses



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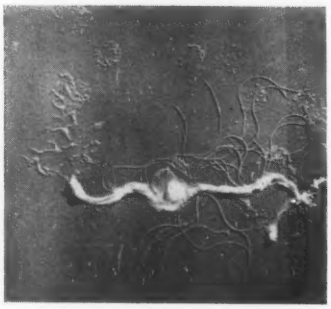

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*American Journal of Clinical Pathology Vol. 33. No. 2. February 1960, pp 144-151 "Application of Refrigerated Microtome in Surgical Pathology" by Bernard Klionsky, M.D. and Othello D. Smith, M.D.

The Journal of Histochemistry and Cytochemistry Vol. 8, No. 5. September, 1960, pp 310 "A Frozen Section Freeze Substitutions Technique and an Improved Cryostat" by Jefrey P. Chang and Samuel H. Hori.

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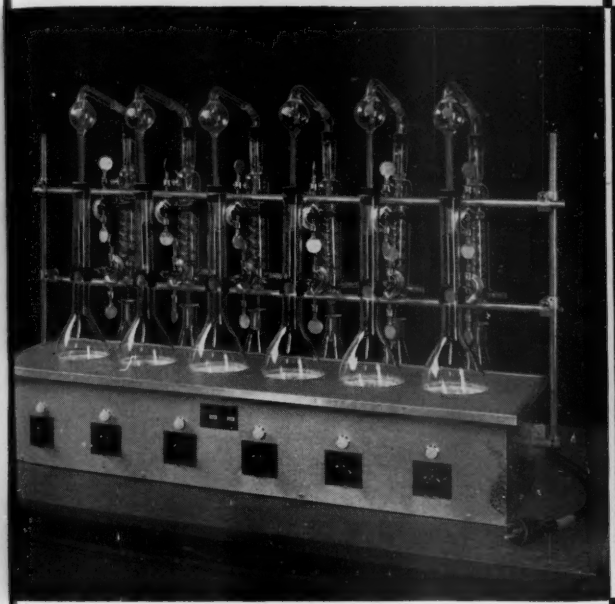

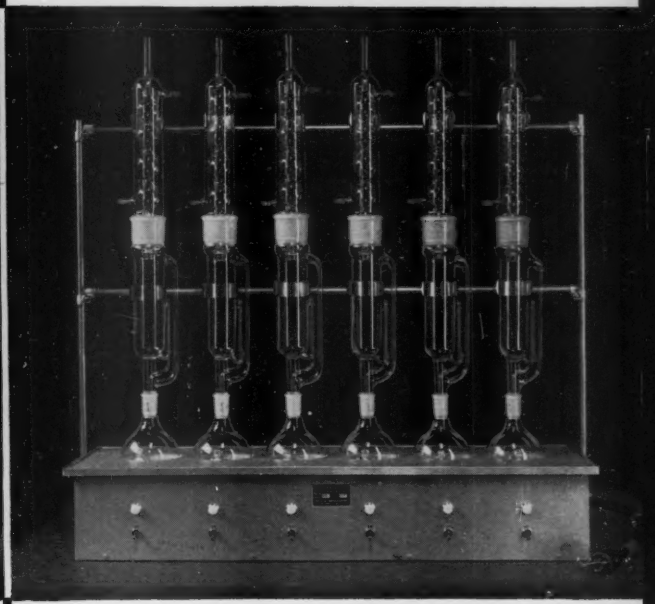

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Letters

Electrostatic Field and Freezing

In a recent report, Salt [*Science* **133**, 458 (1961)] presented experimental data which, in his opinion, show that supercooled water can freeze at a higher temperature in the presence of an electric field than it does in the absence of the field. Because this, if true, could have far-reaching effects in many areas, I feel his findings should be examined critically.

In the first place, Salt makes no mention of the ice-forming nuclei [Mason, *The Physics of Clouds* (Oxford Univ. Press, 1957)] that are present in the atmosphere. While most of these nuclei are usually relatively sparsely distributed and not active at temperatures above −10°C, high concentrations, of laboratory origin and active at near-zero temperatures, may have existed in Salt's laboratory at the time his experiments were performed. These nuclei, under the influence of the electric field, might have entered the supercooled drops and initiated freezing. Second, and more important, a pointed wire probe at a potential of 15,000 volts and held only about ½ inch from the electrically grounded supercooled water undoubtedly produces a corona current. This corona current is not easily detected and begins at a potential far lower than that required for the spark discharge. The possibility that ice-forming nuclei are created by the corona current, perhaps from material from the surface of the wire probe, should not be overlooked.

I suggest that the experiments be repeated in air from which the ice-forming nuclei have been filtered. Further, the electric field should be created by smooth, parallel, plane-to-plane electrodes. Only in this way will the possibility of a corona current be minimized. Until these suggestions are incorporated into the experiment, I do not feel that one can, with any certainty, conclude that an electric field can play a primary role in the initiation of freezing in supercooled water.

DUNCAN C. BLANCHARD
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Blanchard's criticism of my paper is, essentially, that I did not consider the possible action of airborne ice-forming nuclei. He proposes that these may be created, attracted, or concentrated by the electric field or corona and may thus supercontaminate the sample.

This is a reasonable possibility in the case of my exposed water droplets, but how could it be applicable to the insect larvae and rubber-encased water samples, which possess coatings resistant to nucleation from without? Nothing that is known about the nucleation of water would lead one to doubt that my insect larvae and encased water samples were nucleated internally.

Blanchard suggests that the experiments be repeated in clean air with parallel-plate electrodes to minimize the corona current. As stated in my report, I used parallel plates in some tests and found them quite as effective as the probe and plate electrodes.

R. W. SALT
Canada Agriculture Research Station, Lethbridge, Alberta

Advancement of Scientists

T. C. Kahn [*Science* **133**, 656 (1961)] does not, I believe, give sufficient credit to the AAAS for its newly effective policy of publicly relating science to human welfare and culture. I submit that, if the public is kept sufficiently aware of this relation, the advancement of scientists will be adequate. The "Ph.D. scientist," forced into a pecking order with "real doctors," may admire the American Medical Association from afar. Some of us, however, would not like to emulate the AMA, which threatens to replace the physician's concern for human health with "medical economics." I rejoice that the AAAS has not found it necessary to caution scientists not to carry professional insignia on their Cadillacs, as has been reported of a county medical society in California.

One large group of scientists—the teachers—is inadequately recognized and compensated, but I doubt that we would be wise to single out teachers of science for preferential treatment among teachers in general.

JOHN W. DUFFIELD
Industrial Forestry Association, Nisqually, Washington

Enzyme Nomenclature

F. Bernheim's delightful letter [*Science* **133**, 654 (3 Mar. 1961)] is somewhat inaccurate. He says, "In 1957, Wallach and Grisolia [*J. Biol. Chem.* **226**, 277 (1957)] further purified the enzyme, which they said we called hydantoin peptidase—a name we had not thought of." Actually Bernheim, in his article "Enzymes in detoxication" [in *The Enzymes*, J. B. Sumner and K. Myrbäck, Eds. (Academic Press, New York, 1952), vol. 2, pt. 2, p. 862], wrote a subsection entitled, "Hydantoin peptidase," referring to his previously named (1946–1949) hydantoinase.

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I should not like to enter into a controversy over the proper name for the enzyme (actually I do not like very much the ones thus far used) and certainly not with Bernheim. If I had not regarded him with affection I should probably not have recalled the possible relation between our studies (in pyridine metabolism) and his discovery of hydantoinase (hydantoin peptidase). His comment relating political and metabolic status and enzyme nomenclature reminds me of an anecdote I heard when a child. A political appointee, when asked who had won the election, said: "It is a funny thing, we thought we Republicans were going to win, but instead we Democrats won!" (of course, since I was in Spain at the time, I have used some latitude in identifying the political parties).

SANTIAGO GRISOLIA
University of Kansas Medical Center, Kansas City

The Issue of Fluoridation

Local referenda in the first week of March 1961 administered serious defeats to those who have been in favor of the fluoridation of water supplies in Massachusetts. The proposal was voted down two to one in Wellesley and by a smaller margin in Brookline, and discontinuation was voted in Andover.

It is extremely difficult to understand the trend of voting on this issue in towns of the highest socioeconomic and educational levels at a time when the prestige of science, at least with respect to its capacity for achieving its objectives, is higher than ever before. It seems to me that this issue exemplifies the contemporary confrontation of science and antiscience, because of the overwhelming weight of scientific authority on the pro side—such as that of the official associations of the dental profession and the public health authorities at all governmental levels. If this evaluation of the issue is valid, one must draw the conclusion that communication between the scientific community and the public is still in a highly unsatisfactory state and that it should be a matter of continuing concern to the AAAS. This aspect of the situation may transcend in importance the lost potential for improvement in dental health.

Discontinuance of the fluoridation program in Andover after 5 years may provide the basis for another field study for interested investigators. But of even greater interest would be results of a competent sociological study to uncover the basic reasons for the astounding successes of the small, fanatical groups that have been organized to oppose the scientific experts. This issue may, in a sense, serve as a measure of the effectiveness of the AAAS with respect to one of its prime objectives—communication with the public at large.

LEO LEVINE
Jamaica Plain, Massachusetts

Government and Education

A recent editorial [*Science* **133**, 1043 (7 Apr. 1961)] confirms the need for truly liberal members of the AAAS to make themselves heard. I resigned from the AAAS in protest over the brave new social stand promulgated by the Association under the guise of "Science in the News." Now in this editorial, the Association has come out forthrightly for federal interference in local education.

The worth-whileness of integration should not blind anyone to the danger of encouraging Congress to contribute money *conditionally* to education. The conditions will multiply with time, to conform to every demagogic prejudice of any group wielding sufficient votes. I hope the editors of *Science* are prepared to convince Congress that somewhere between Negroes, Jews, Catholics, Nordics, Birchists, Irish, Baptists, Communists, Fundamentalists, Pragmatists, Conscientious Objectors, Beatniks, and Snuff-takers there is a fine line that makes federal interference right or wrong. If Congress is not convinced, the new loyalty oaths will be a multiple-choice form several pages in length.

IVOR CORNMAN
5702 Sherrier Place, NW, Washington, D.C.

We wish to point out that what appears in Science, *either in editorials, in the news section, among the articles, or elsewhere, cannot in all fairness be called a "social stand promulgated by the Association."*—ED.

Reprints of Snow Address

C. P. Snow's significant address before the AAAS in December, "The moral un-neutrality of science" [*Science* **133**, 245 (27 Jan. 1961)] has been reprinted in pamphlet form by the Peace Education Program of the American Friends Service Committee.

We would like to let your readers know that the pamphlet is available at 10 cents a copy from Peace Literature Service, American Friends Service Committee, 160 North 15 St., Philadelphia 2, Pa.

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The Reluctant Dragon

Censorship is a many-headed dragon: once beheaded, it returns with scarcely diminished vigor to the fray. On 17 March President Kennedy ordered immediate termination of the long-standing policy of intercepting all but first-class mail from Iron-Curtain countries. But 4 days later Representative Francis E. Walter introduced a bill that would restore the policy and give it a legislative basis that it had not had in the past. His bill would create a "Comptroller of Foreign Propaganda" in the Customs Office of the Treasury Department and would require the registration of any foreigner who used our mails for distribution of "foreign propaganda" to register "as an agent of a foreign principal who is acting within the United States."

If this bill or its companion bill in the Senate were to become law, any book or magazine from any country, friendly or hostile, could be impounded unless its mailing clerks or other distributors were registered as agents of a foreign principal acting in the United States. For any printed matter may be regarded as propaganda: under the previous policy an issue of the London *Economist* and hosts of books from abroad were arbitrarily impounded. And what would prevent the "Comptroller" from deciding that scholarly and scientific articles and reprints are foreign propaganda?

The bill is wrong in principle: it would impose a censorship that is inconsistent with the practice of that liberal democracy upon which we base our society. It is symbolic of fear and manifests a lack of faith in freedom and in the good sense and good judgment of American citizens. Contrast the words of Jefferson's first inaugural address, "Error of Opinion may be tolerated where reason is left free to combat it," with Mr. Walter's fearful comment about what will happen if the President's action is allowed to stand, "Poison will be poured into the veins of our society without restriction and without notice or warning of its nature."

The bill is not only wrong in principle. It will also have deleterious effects on the scholarly and scientific appraisal of what goes on abroad. Our self-interest alone dictates that we encourage rather than impede the flow of information of all kinds about what goes on elsewhere in the world and especially about what is happening behind the Iron Curtain. Congress recognized the desirability of this when it decreed in the National Defense Education Act of 1958 that the National Science Foundation step up its efforts to make scientific information available to American scientists. The Walter bill is no empty threat to this activity that the NSF now carries on through its Science Information Service: under the previous policy, *Mathematical Reviews* received no Soviet journals for one 2-year period.

What are the chances for the bill? As of now the bill has been carried over "without prejudice" to the Consent Calendar of the House. If no objections are made to it on the next "consent" day, 5 June, it will pass the House without debate, without hearings, and without a vote. This is what happened to a similar bill introduced by Mr. Walter last year, but that bill died in the Senate. The current bill is not likely to have such easy sledding in the House, for it faces opposition from the Administration: administration supporters will not readily let it slide through unopposed.—G.DuS.

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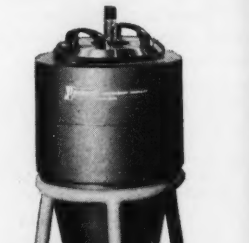

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CURRENT PROBLEMS IN RESEARCH

Some Problems of Vertebrate Paleontology

The study of fossil vertebrates elucidates the general principles of evolutionary biology.

George Gaylord Simpson

Paleontologists sometimes argue among themselves over whether they really are, or should be, geologists or biologists. The discussion is usually futile and sometimes absurd. Paleontology is characterized, but is not fully defined, by having its own objective subject matter: fossils. Fossils occur in rocks, and they are organisms. Their extended study necessarily overlaps widely into both of the broader (or more miscellaneous) sciences of geology and biology. Without really departing from his own science, a paleontologist may even find himself engaged in work that does not directly involve any fossils and that is quite strictly geological (for example, sedimentation) or biological (for example, genetics).

Traditionally, invertebrate paleontologists have been more geologically, and vertebrate paleontologists more biologically, oriented. The tradition arose because invertebrate paleontology, both commercial and academic, has always had an important role as a service branch of geology, supplying most of the correlations needed for stratigraphy and for historical geology in general. Vertebrate paleontology has had few commercial applications, and it has tended to attract students who were interested in studying organisms as such more than in rendering a practical service to geologists. That tradition still has an evident influence on the two fields, but the distinction is now breaking down. Both invertebrate and vertebrate paleontology are becoming broader, and paleontologists in both fields are becoming more diverse in approaches, methods, and aims.

In view of the great and still increasing spread of subject matter, a major problem of vertebrate paleontology is that of manpower. There simply are not enough vertebrate paleontologists, or enough positions for them, for adequate and consistent cultivation of the whole subject. Definition is difficult and may even be invidious, but if by "vertebrate paleontologist" we mean someone who has vertebrate paleontology as his primary field and who is working continuously in it at an independent, professional research level, there are only about 65 vertebrate paleontologists in North America and perhaps as many more in all the rest of the world (*1*). They are, however, backed up by a corps of technical personnel who do little independent research themselves but who greatly promote such research. It is further true that a significant proportion of the important research in vertebrate paleontology is done by people who are not primarily professionals in this subject but who work in it occasionally or marginally. The total number of people now making some contribution to the science runs well into the hundreds. Nevertheless, it is an unfortunate fact that some brilliant new possibilities opening up in the field of vertebrate paleontology are not being followed up simply because there are not enough specialists to work on all of them.

The most basic essentials for continued progress in vertebrate paleontology are still the same as the earliest activities, and will continue to be so as far as can be seen into the future. Involved here are the flow of new discoveries and data from the field, laboratory preparation of specimens, and study of their morphology and taxonomy. Much the greatest part of current effort is devoted to these classical but continuously necessary activities. There are still new fossil fields to be discovered. Renewed collecting in known fields, often by campaigns over many years, is necessary to make more nearly adequate collections and to provide field data up to modern standards, which are far more rigorous than the standards of even a few years ago. Laboratory preparation is still a bottleneck, one of the reasons why vertebrate paleontology is often a slow science. Decades may necessarily elapse between beginning a large project with field work and ending it with final publication of the results. In addition, almost all the basic taxonomy of a generation or more ago now requires revision in the light not only of new materials but also of new principles and standards. (This does not mean that the earlier work was wasted; the new principles and standards arose from it, and many of its data are as useful as ever.)

It is precisely here, in its most basic activities, that vertebrate paleontology has many of its most striking recent discoveries, and improvements in techniques and approaches, and also has its continuing problems. It must be stressed again that here is not only the great bulk of work in vertebrate paleontology but also the most fundamental aspect of that work. It is further to be emphasized that much of the current progress and many of the most pressing prob-

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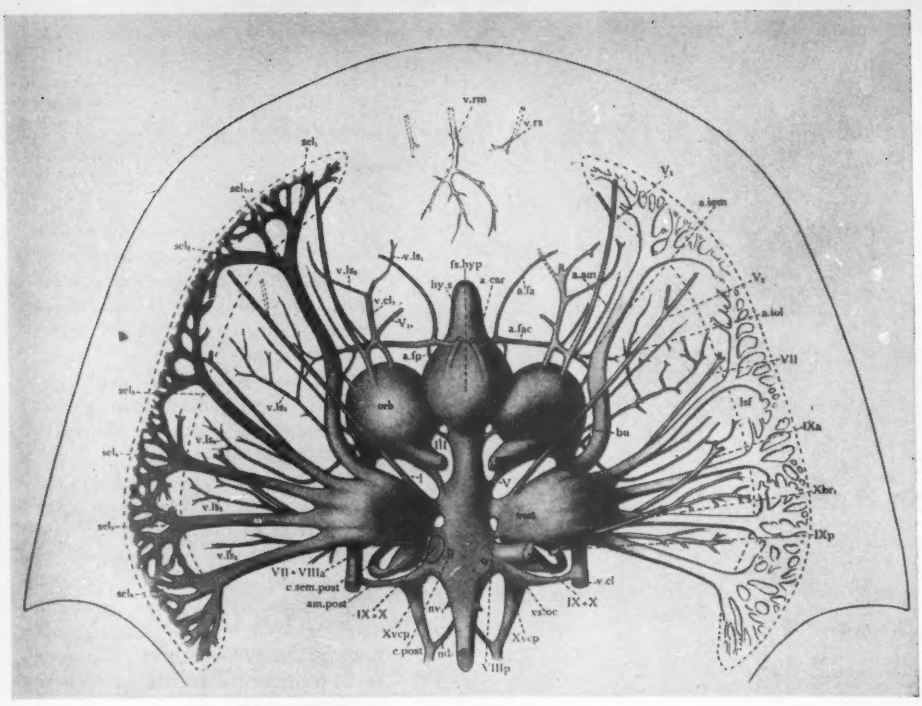

Fig. 1. Detailed endocranial anatomy of an ancient fossil vertebrate, *Kiaeraspis auchenaspidoides*, a jawless fish from the late Silurian of Spitsbergen. [After E. A. Stensiö]

lems are on the geological side of the subject, in sedimentation, stratigraphy, correlation, chronology, and related topics. Nevertheless, and solely because of limitations of space, those parts of the subject are treated only incidentally in the following discussion. My purpose here is to consider problems of broader and more theoretical biological interpretation that arise after the basic data, taxonomic and geologic, are in hand. Even within that more limited scope, the treatment can be only a sampling and an exemplification of a few problems and in no sense a review of the field (*2*). Some aspects of morphology and systematics, closely related to the basic data, are considered briefly before certain interpretive problems more removed from that level are treated.

Morphology

Even in its 18th-century beginnings, vertebrate paleontology was never confined to collection, preparation, description, and classification. It is, however, especially characteristic of the work done in recent years—the 1940's and 1950's—that there has been a great irruption of new ideas, new goals of interpretation, renewed efforts toward theorizing in broader ways and at more generalized levels. At present there seems to be some reaction against that tendency, and a certain ambivalence has arisen in the profession. This is not a clear-cut dichotomy into an *école des faits* and an *école des idées* but only a difference in the points of view of those who would lay greater stress on one or the other of what are, after all, mutually dependent and equally necessary aspects of the same whole. There is the need, on one hand, for more detailed, complete, and accurate anatomical observation, description, and illustration (*3*), but also, on the other, for generalization and theoretical formulation that alone can make such data meaningful.

On the observational side, vertebrate comparative anatomy, not only of fossil but also of recent animals, has become largely the province of vertebrate paleontology. It is indicative that outstanding textbooks in that field are those by Romer, a vertebrate paleontologist. All vertebrate paleontologists have perforce been anatomists, but a modern school of morphology has arisen largely through the efforts of Watson in England, Gregory in the United States, and Stensiö in Sweden and has been carried on especially by their respective students. To take a single school as an example, Stensiö and his students have investigated the anatomy of many early vertebrates in almost incredible detail and have produced reconstructions that often incidentally have striking esthetic values (*4*) (see Fig. 1). The methods involve not only delicate macroscopic preparation but also thin sections, serial sections, and plastic reconstructions. Study of all fossil species in equal detail is neither desirable nor possible, but application of this approach to at least some characteristic members of all major groups is an eventual necessity, and a beginning has barely been made. As regards later vertebrates, Whitmore's study of some Oligocene artiodactyl skulls is not quite, but unfortunately almost, unique (*5*).

The most ardent advocates of descriptive anatomy for its own sake do not deny the need for some generalizing principles. In this respect there are two schools. A small group consisting mainly of Naef, Kälin, and their students, notably Zangerl in the United States, has approached comparative anatomy as a self-contained subject with its own principles independent of those of any other biological discipline (*6*). For them, generalization is by abstraction of a "Morphotypus," which is essentially the archetype of the pre-evolutionary typological idealistic morphologists or *Naturphilosophen* exemplified by Goethe. For the great majority of vertebrate

paleontological morphologists, however, the central principle is now that of evolutionary homology—derivation of structures from a common ancestry and their modification in the course of phylogenetic descent.

From the latter point of view, greatest interest attaches to major transformations that are involved also in important problems of systematics and of evolutionary theory. The fish-amphibian transformation is being studied especially by Jarvik, in the laboratories under Stensiö's direction (*4*), and also by Westoll, Romer, and others. As another example, the reptile-mammal transition, outlined in a general way long since, is now under new attack in greater phylogenetic and morphogenetic detail by, among many others, Brink and Crompton in South Africa; Watson, Parrington, and Westoll in England; and Romer, Patterson, and Olson in the United States (*7*). This transition was a main subject of a colloqium in Oxford, England, in 1960. Another classical problem now under renewed attack concerns the evolutionary morphogenesis of mammalian molar teeth. One of the triumphs of paleontological morphology of the late 19th and early 20th centuries was the discovery by Cope and Osborn that therian (that is, both marsupial and placental) molar dentitions all went through a common stage now called tribosphenic. The origin of the tribosphenic dentition, however, is still quite uncertain, but it is being studied with new evidence from Mesozoic mammals and mammal-like reptiles. That was a main subject of another international meeting in 1960, organized by Vandebroek in Brussels (*8*).

Classic approaches to morphology, even when evolutionary in principle, deal typically with individual structures in a somewhat static way. Newer, more dynamic approaches are now also being followed. One of these approaches, already with a rather large literature and applications of well-developed methodology to a great variety of vertebrate groups, deals with ontogenetic structural changes, especially as influenced by relative growth (*9*). Another, which seems at least equally promising but still presents serious unsolved methodological problems, has to do with covariation, correlation, and association of anatomical character complexes within populations and among groups of related forms (*10*). Studies of the more classic sort are still of prime importance and not to be disparaged, but the most striking progress in morphological principles will probably be in these newer fields in the near future, and in work relating morphology to the biology of the individual (*11*).

Systematics

As early as the 18th century fossil vertebrates were being classified according to the same system as Recent animals, and of course this still is and always must be a basic and principal activity in this science, perhaps the most basic of all. Since Linnaeus and Cuvier, in addition to innumerable more superficial changes of form and content, there have been two deep revolutions in the principles of systematics. Vertebrate paleontology has been influenced by and has contributed to both. First was the change from special creation to evolution as an explanation for the diversity of life, and hence to the order in nature which makes classification possible. Second, more subtle and harder to grasp but equally fundamental, was the change from classification in which categories were defined by typological abstractions of constant characters and individuals were the members of taxa to classification with phylogenetically defined categories and with varying populations as the members of taxa. In the latter revolution, not yet complete, vertebrate paleontologists have been both leaders and laggards. Some were pioneers in using the conceptually statistical, sample-population approach to taxa and in using phylogenetic categories, and others still do not adopt either of those concepts (*12*).

The problems of obtaining adequate, unbiased samples and, alternatively, of making proper allowances and corrections for inadequacies and biases are particularly acute in paleontological systematics. Almost all vertebrate paleontologists have become aware of those special problems, most of which have been identified and listed, but there are still few specific and concrete studies. Two examples of the kind of studies that are pertinent here may be cited. Olson has presented a model theoretical and practical study of size distributions in samples of growing animals (*13*). Shotwell has attempted to separate members of proximal and distant communities in quarry accumulations by calculating the number of bones recovered per individual (*14*). It is irrelevant, for our purposes, that Shotwell's method may prove to have restricted applicability (*15*). Ideas of that sort and their testing, both by theoretical models and by particular actual occurrences, are badly needed if we are to make adequate evaluations of the fossil record and place generalizations about it on a sounder basis.

Changes in the concept of species and in the interpretation of samples in recent years have been so profound that practically no "species" of fossil vertebrates described more than 20 years ago, and not all of those described since then, can now be taken at face value as properly defined and biologically significant species of natural populations. Fortunately, that situation is changing now, and biologically sound specific descriptions are so numerous in recent work as hardly to need exemplification. One consequence of the previous situation has been that most sound paleontological studies of systematics, and of the evolutionary processes that underlie systematics, have hitherto necessarily been above the species level. Knowledge of structure and processes within species, or between closely related species, has come mostly from recent animals and has lacked a significant time dimension. It is, however, now clear that such studies can be based on some fossil groups with particularly favorable sampling conditions, and this indicates a whole field of important problems to which vertebrate paleontology may soon be expected to make more significant contributions.

As regards the systematics of higher categories, the situation in vertebrate paleontology has long been more favorable. Most of our theoretical understanding of the nature of such categories and of how the corresponding taxa have evolved has been provided by vertebrate paleontology, and this is one of its most active current fields of research. Moreover, in most groups of vertebrates (teleost fishes and birds are the outstanding exceptions) actual classification at high-categorical levels is now based primarily on paleontological data. Many of the important current problems in this field arise from increasing evidence of some degree of polyphyly and parallel evolution at high levels—evidence which makes the delimitation of, for instance, the classes Amphibia, Reptilia, and especially Mammalia increasingly difficult and disputed (*16*) (see Fig. 2). Among the many examples of similar problems in systematics at successively lower levels

(*17*), mention may be made of work on the separation of the orders Insectivora and Primates (or the dismemberment of those orders); on recognition of suborders of the order Rodentia, which probably does not have natural suborders (*18*); and on redefinition of genera and phyletic lines in the supposedly well-known horse family (*19*). The examples are all among mammals, but others of the kind occur in every vertebrate class.

Functional Biology of Individuals and of Species

Vertebrate paleontologists have always attempted to draw inferences about general functional characteristics of prehistoric animals—how they moved, what they ate, and the like. Such inferences were based almost entirely (and necessarily, as it seemed) on analogies with similar, living animals. They tended to become mere fantasies when referring to structures for which there are no such analogies—for example, the dorsal fins of some Permian pelycosaurs, the "hoods" of some duck-billed dinosaurs, or the claws of the phylogenetically ungulate chalicotheres. Such analogical, and often more subjective and anecdotal than scientifically inductive, studies reached their height in the *"Palaeobiologie"* of Abel, half a century ago. After Abel, analogies, quite properly, were still sought, but for some years the field seemed to have little further potential for the production of new ideas or of more rigorous methods.

Here we are in the midst of a definite revival. Problems are being more broadly conceived but more strictly defined, and better methods are being devised to solve them. In part, the current approach involves greater precision and better analogical evidence in application to the same kinds of problems as those attacked earlier in a looser way. This is the approach in reconstructions and functional analysis of musculature [for example, of ceratopsians, by Haas (*20*), following earlier work by Lull and others] or in interpretation of limb function from trackways [for example, in amphibians, by Peabody (*21*), also following and improving on earlier work by many hands]. In other instances, earlier intuitive judgments have been replaced by quantitative experimental data derived from working models—for example, in studies of early reptilian auditory function, by Hotton (*22*).

Similar use of models has already been made in studies of a variety of functional problems (for example, of locomotion in early fishes and in pterodactyls), and the method is capable of much further extension. It has the advantage not only of giving quantitative results but also of being applicable to structures without close analogs in living animals. In some instances study by means of mathematical, rather than physical, models and analyses has the same advantages. For example, the problem of the pelycosaur dorsal fin, mentioned above, seems essentially solved by Romer's demonstration that the regression relationship of fin area to body volume is appropriate to the functioning of the fin as a temperature-regulating mechanism (*23*) (see Fig. 3).

Those successful attacks on old problems by new methods are supplemented in an even more interesting way by the formulation and at least partial solution of quite new problems, either over-

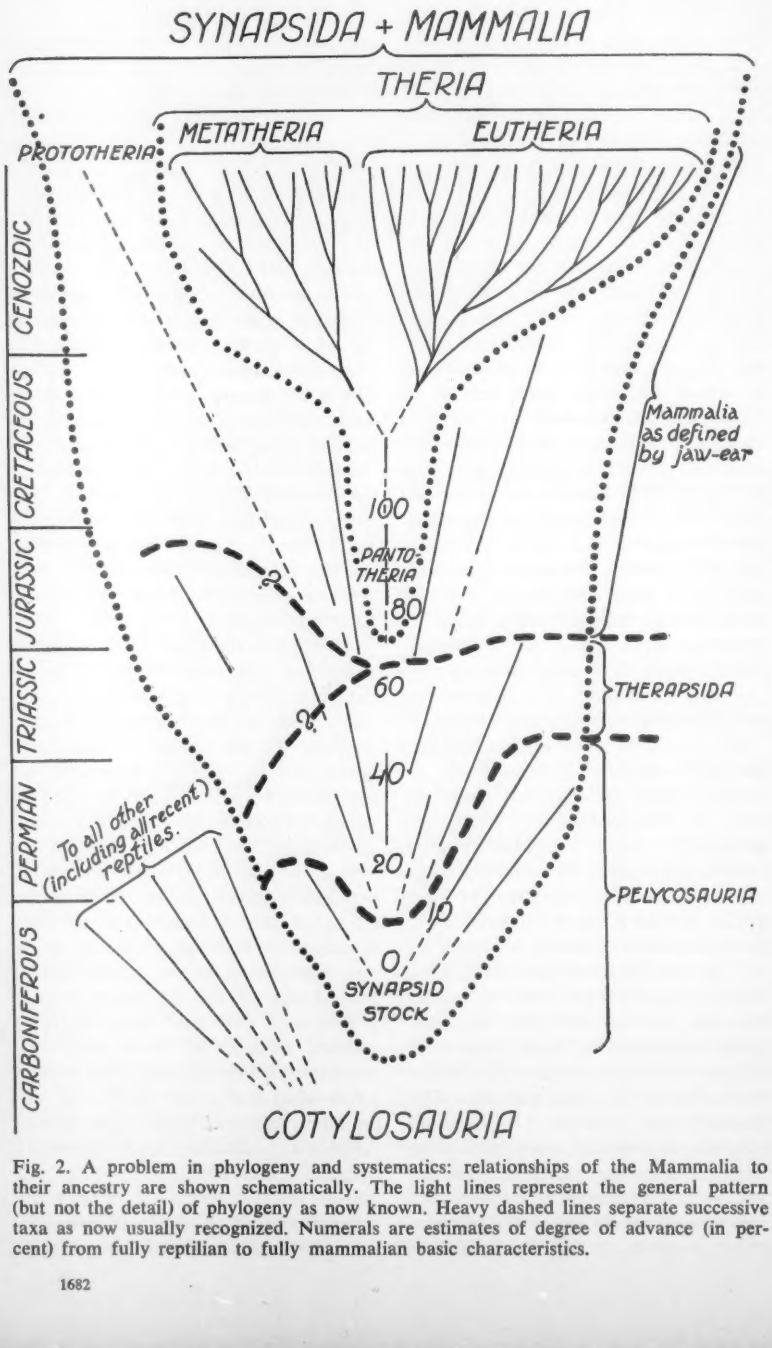

Fig. 2. A problem in phylogeny and systematics: relationships of the Mammalia to their ancestry are shown schematically. The light lines represent the general pattern (but not the detail) of phylogeny as now known. Heavy dashed lines separate successive taxa as now usually recognized. Numerals are estimates of degree of advance (in percent) from fully reptilian to fully mammalian basic characteristics.

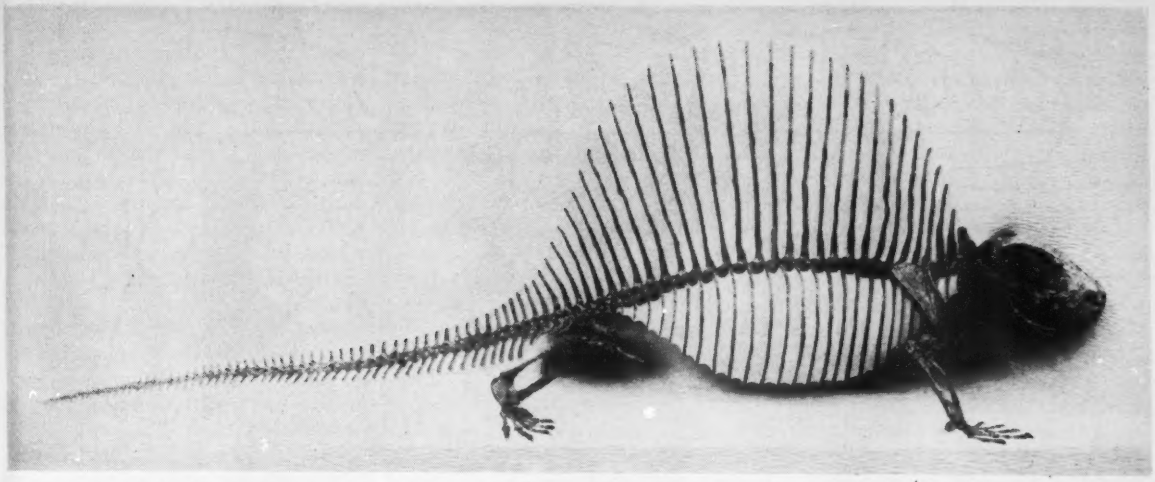

Fig. 3. A paleobiological problem: the Permian reptile *Dimetrodon*, with a large dorsal fin of long-disputed function, now interpreted as a heat-regulating device. [Museum of Comparative Zoölogy, Harvard University]

looked previously or believed insoluble on the basis of fossil materials. An important example is the biological consideration not only of single structures but of whole organ systems as developmental and correlational fields. Butler pioneered in that approach some time since (*24*), and it is being carried further not only by Butler but also by others, notably Kurtén (*25*) (see Fig. 4). Kurtén, who is particularly ingenious in quantitative biological approaches to paleontology, has also developed life tables, survivorship curves, and age pyramids for fossil populations (*25*).

Such studies of structures and of populations broaden the interpretive capacity of paleontology by bringing in functional and dynamic aspects previously amenable to profitable study only among living animals. They have, however, still greater potential importance because they can bring an extended time dimension to such studies and thus supply an evolutionary basis not attainable from study of recent animals alone. That potential is barely beginning to be realized in the present pioneering phase, but the possibilities are certainly great.

Faunas, Ecology, and Biogeography

A next step in deepening and broadening the contributions of vertebrate paleontology to general biology is the consideration not only of individuals and of specific populations but also of whole faunas. This, again, is not a new field but goes back in a tentative and subjective way to the very beginnings of the science. In retrospect, it is seen to have had a turning point and to have begun to enter a new era with the work of W. D. Matthew in the first three decades of this century. Since then, and at a pace that is still accelerating, problems outlined or exemplified by Matthew have been attacked by more varied, more rigorous, and in good part more quantitative methods, and new kinds of problems in the same general field have been formulated.

Here the ideal is the functional study of whole biotas, plants, invertebrates, and vertebrates in relation to their environments, to earlier and later biotas, and to the contemporaneous biotas of other areas. Needless to say, this ideal has not been and in fact cannot be fully achieved; not even a recent biota has been fully described, still less functionally interpreted, in accordance with the ideal. Nevertheless, it is being approached in numerous and varied, necessarily more restricted and somewhat piecemeal, studies. Data for this kind of study come from all the fields that have been previously mentioned, and from still others. Here the geological basis, which I do not have space to consider, becomes particularly important—especially sedimentation, geochronology, correlation, and stratigraphy, including microstratigraphy, in which faunal associations are tied in very precisely, down to millimeters in some instances, with successive stratigraphic levels. Sampling problems, already briefly mentioned, are here acute, and there is great need for better understanding of the factors that act between the living fauna and the preservation of part of it in fossil state, as well as factors involved in the formation of fossil deposits in general. Study of such factors has been called "biostratonomy" by Weigelt and "taphonomy" by Efremov, although it may be a little premature to designate as distinct sciences fields in which, unfortunately, there is as yet little concrete accomplishment.

Basic biological data on this subject are the taxa present in a given fossil association and their relative abundance. The present tendency and need is to narrow specifications to the point where a fossil association may, perhaps with minor exceptions, be taken as representative of a single ecological community. M. C. McKenna, among others, has recently exemplified the graphic and tabular presentation of such data, his examples being strictly localized mammalian faunules within a broader regional fauna of early Eocene age (*26*). A next step involves inference about the ecological characteristics of the various taxa and thence about the ecological structure of the community. The community characteristics are related in turn to the environmental situation, and in favorable instances community differences can be related to ecological environmental distributions on a local or microgeographic basis. A brilliant example at this level has been provided by Olson, who in a sequence of Permian vertebrate faunas not only has demonstrated the microgeographic distribution of ecological types correlated with sedimentary facies (Figs. 5

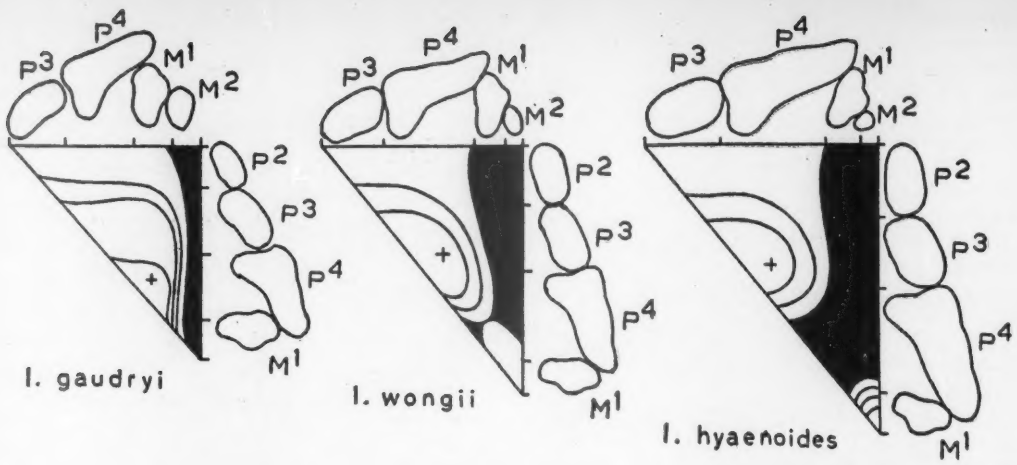

Fig. 4. Correlation fields in the dentitions of fossil mammals: upper-cheek teeth of three species of the Pliocene hyena *Ictitherium*. The triangular fields indicate the correlation between teeth diagrammatically indicated vertically above and horizontally to the right. For the black areas the coefficient of correlation z is less than .50. The contours represent higher values, in steps of .10. [After B. Kurtén]

and 6) but also has followed ecological and evolutionary changes through a sequence of environments over considerable periods of time (*27*).

Biogeographical study at the next higher level, in which more strictly historical-evolutionary elements are in interplay with ecological factors, concerns the distributions of evolving species and faunas over larger areas, up to continental size. Of special interest here is the evolutionary origin and geographic emplacement of recent biotas within the various biotic regions of the world. There have been many studies at this level for particular groups of plants and animals, but mostly on the basis of living organisms only. Without some control by directly historical—that is, paleontological—evidence, such conclusions must be viewed with strong reservations. For mammals, especially, and particularly for those of Europe and North America, there is already an enormous accumulation of late Cenozoic specimens and data, but almost all of them have still to be analyzed adequately from this point of view. There is here a particularly large number of fascinating problems soluble by materials at hand or readily obtainable and only awaiting students with the ability, interest, and time to work on them.

There are, to be sure, many published papers on geographic shifts of particular species and genera, and a few concerned with more extensive faunal associations, especially during late Cenozoic climatic changes. An example is the recent demonstration by Hibbard of the southern movement of some warm-climate vertebrates in the United States as climates became cooler in the late Cenozoic (*28*). For the most part, however, the scattered studies so far made lack both generality and precision. An example of a broader approach is Shotwell's study of morphological change, geographic distribution, and correlation with distributional changes in vegetation for two related families of rodents from late Eocene to Recent in the western United States (*29*). Here, as usual, the available data still are not wholly adequate, but this may be viewed as a sort of pilot study that indicates a profitable direction for future research.

Study on a still broader scale is that of the historical development of whole regional and continental faunas and of relationships among them. Darwin was already impressed by this subject as a young man when he collected fossil mammals in South America on the voyage of the *Beagle*, and in fact it was one of the two principal lines of evidence that converted him to belief in evolution. (The other was the differentiation and the evident affinities of birds in the Galápagos Islands.) Matthew devoted more detailed attention to the subject, and he has successors who have followed in his footsteps and have, with constantly improved data, gone well beyond him. The main outlines of Cenozoic and mostly mammalian faunal evolution are now well established for Europe, North America, and South America, and Eurasian–North American and North American–South American faunal relationships and interchanges are also fairly well understood (*30*). Of course, even for these best-known sequences, innumerable details remain to be filled in, and the degree of precision is seriously limited by the still unsatisfactory status of intercontinental correlation. Elsewhere, great blocks of evidence are still lacking or are extremely inadequate—for example, for the whole Tertiary in Australia, the early Tertiary in Africa, and the early Paleocene throughout the world except for the Rocky Mountain region of the United States.

Currently accepted general principles of historical biogeography and its (rather few) special methods, such as the quantification of faunal resemblances (*31*), are derived largely from paleomammalogy in the tradition of Darwin and Matthew. This is evident, for instance, in a fine recent treatise on the historical biogeography of nonmarine vertebrates, which happens to have been written not by a vertebrate paleontologist or a mammalogist but by an entomologist, Darlington (*32*). Such studies, departing from a geological basis at one end, also have repercussions in geology at the other end. For example, mammalian migrations and faunal relationships practically rule out any real possibility that significant continental drift has occurred during the Cenozoic.

Evolution

It is an extraordinary but explicable fact that evolution was not discovered by vertebrate paleontologists; the rather complex explanation hinges on the inadequacy of data before 1859 and on the philosophy and prestige of Cuvier, the first professional vertebrate paleontologist. After publication of *The Origin of Species,* vertebrate paleontologists rapidly became evolutionists, and in the late 19th and early 20th centuries they developed three principal roles in this respect. First, they supplied clinching evidence of the truth of evolution. Second, along with the invertebrate paleontologists and the paleobotanists, they undertook to trace the actual history of evolving organisms. Third, they proposed various theories and so-called laws of evolution.

The truth of evolution has been adequately established long since, and although every paleontological discovery adds to the proof, the paleontologist's role in that connection is no longer important. Tracing the history of organisms is still a central purpose of paleontologists, who are now advancing more rapidly than ever but are still not even in full sight of this goal. The many problems and gaps in that field are not under consideration in this brief review. The third role is now more important than ever before, but its nature has changed radically in the last 20 years (*33*).

An eminent vertebrate paleontologist, Lehman, recently declared: "*On ne crois plus guère aux lois de l'évolution*" (*3*). He was not, of course, raising doubts about the fact of evolution but expressing disillusionment with some of the theoretical preoccupations of his predecessors and recommending stricter concentration on morphology. Early evolutionary vertebrate paleontologists were much concerned with developing generalizations, which they often incorrectly called "laws," on the basis of what they knew of the fossil record. Some of these generalizations have proved to be incorrect; others have had to be more or less profoundly modified; and a few have been validated as generalizations open to exception. Orthogenesis, which was not really first proposed by vertebrate paleontologists but was accepted by many of them and is still often considered a paleontological "law," is in the first category. As defined in the most usual of its many and sometimes conflicting definitions, it flatly is not true; lineages are not impelled by some internal or supernal force to keep on evolving indefinitely in the same direction (*33*). "Dollo's law" of the irreversibility of evolution is an example in the second category. It was partly wrong as Dollo himself stated it, but it reflected a correct generalization now embraced in the broader statement of evolutionary irrevocability: organisms do not, as a rule, wholly return to any ancestral condition nor yet wholly lose effects of any ancestral condition (*33*). Examples in the third category are "Cope's law," that individuals in evolving lineages tend to become larger as time goes on (*34*), or "Williston's

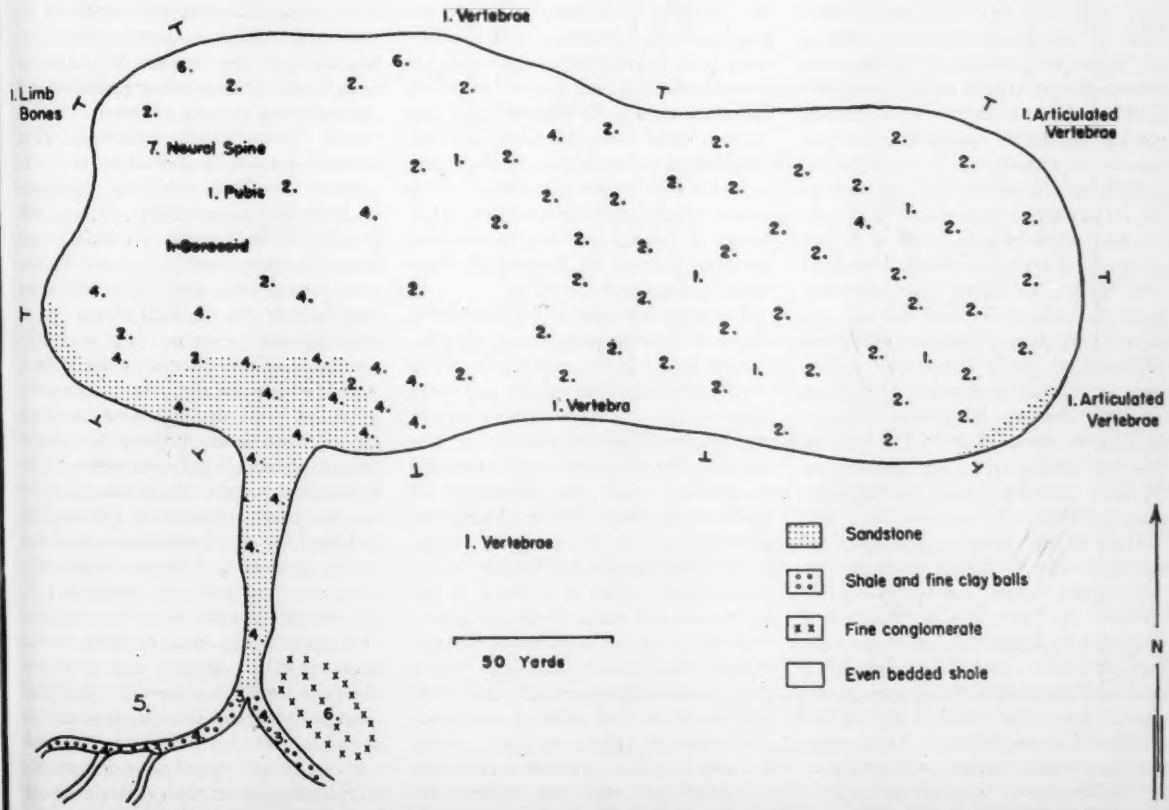

Fig. 5. An example of paleoecological data and interpretation. The map represents a Permian pond, its shore, and a small tributary stream, now represented by sediments, as keyed at lower right. The numbers indicate precise sites of discovery of different kinds of fossil vertebrates. Correlation of kinds of fossils with the ecological situation is evident. [After E. C. Olson]

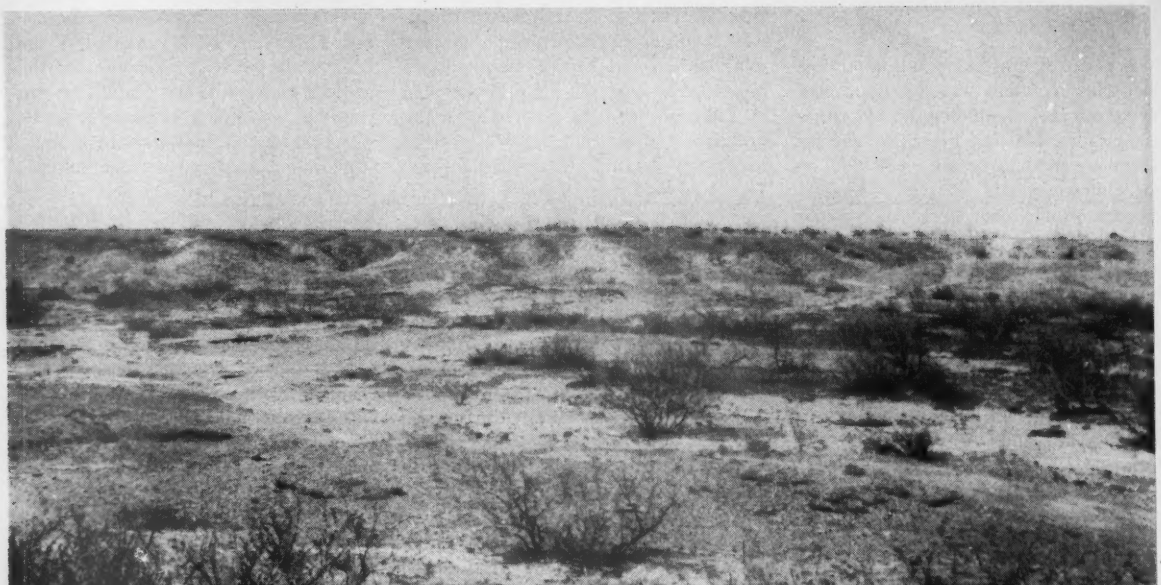

Fig. 6. Sediments of a Permian pond as exposed today in Texas. This is the exposure of the fossil deposit mapped in Fig. 5. [Hitherto unpublished photograph by E. C. Olson, University of Chicago]

law" (*35*), that repeated similar structures in individual organisms tend in the course of evolution to become less numerous and functionally more differentiated (*36*). Both are frequently general tendencies, though there are numerous exceptions.

Such generalizations are still part of the interpretive instrumentation of vertebrate paleontologists, and it is not quite true that they no longer believe in what used to be called "laws of evolution." It is, however, true that this approach has proved rather sterile, has produced no really novel and striking ideas in the last generation or so, and probably deserves its present unpopularity. The whole effort to find laws in this field analogous to the laws of the physical sciences was methodologically mistaken.

Most of the early contributions of vertebrate paleontologists to theories of evolutionary factors and forces (as opposed to the descriptive generalizations that were mistaken for laws) also now seem sterile in retrospect. Cope developed his own form of Neo-Lamarckism, popular for a time but now wholly discredited. Osborn espoused a somewhat nebulous, idiosyncratic, vitalistic-finalistic theory never accepted by any of his colleagues. After making a good start in it, Scott abandoned the whole field of evolutionary theory as futile. Broom called in familiar spirits to explain evolution. Matthew took a somewhat naive form of Neo-Darwinism for granted and did little to test or to advance the theory. In each of these and in many other cases that could be cited, a significant factor is that the vertebrate paleontologists were operating in an almost watertight compartment. They tended to neglect and were sometimes quite ignorant of the progress of theoretical biology in other fields.

The situation now is very different. The main (not the only) body of evolutionary theory today, sometimes called "Neo-Darwinian" but usually and more appropriately "synthetic," arose largely as a synthesis between genetics and systematics, but it immediately expanded to embrace other and eventually all fields of the life sciences. Vertebrate paleontology early began to play a large and in some respects crucial role in that development, a role in which it is not compartmented but is firmly integrated with almost all the branches of biology. (Other paleontologists have of course also contributed importantly, but up to now more has been done by vertebrate paleontologists than by the others, probably because they tend to be more biologically oriented and because for certain groups they have particularly good bodies of pertinent and well-analyzed data.)

In terms of the broadest aspect of its role, paleontology shows what has happened in the course of evolution over large groups of organisms and through long periods of time. In other words, paleontology specifies what really has to be explained by any explanatory theory of evolution. Put in its weakest and most negative form, the conclusion now most generally supported is that there is nothing in the fossil record that cannot conceivably be explained by the synthetic theory, or at least by an expanded and probably somewhat modified form of the theory. A note of caution and even in some respects of opposition has been sounded by some students, notably by Olson among vertebrate paleontologists (*37*). In broadest essence, the criticisms point out that other explanations are *possible* and that the synthetic theory has not clearly explained *everything*—propositions that must certainly be granted by all reasonable students of the subject. The position of those of us who do open-mindedly support the synthetic theory is simply that no other explanations yet advanced seem to us nearly as probable, and that so far no phenomenon clearly established as real is plainly inexplicable under the synthetic theory or definitely contradicts it.

Within the general field of synthetic theory, paleontology provides concrete

evidence and examples that can be obtained in no other way, covering periods of time not observable by experimentation or by neosystematics. Olson and other critics are certainly right and are playing a useful part in pointing out that *all* the phenomena revealed by paleontology do have to be explained, that these could conceivably controvert parts, at least, of the synthetic theory (although they have not done so), and that they must inevitably both expand and modify evolutionary theory.

One basic aspect of these problems is the firmer integration of paleontological and neontological studies and improvement of genetical interpretation of the fossil record. That involves especially studies of variation and heredity of characters that can be observed in fossils and for which control studies can be made on recent animals. Along with an increasing number of other students, Bader has recently devoted attention to this subject (*38*). Work on morphological integration and structural correlation, previously mentioned, is also pertinent here. In a related field, Kurtén has been able to measure the intensity of mortality selection in some fossil populations and has found, as have a number of neontologists in parallel studies, that the intensity of natural selection on apparently trivial characters may be amazingly great (*39*).

More peculiarly paleontological is the study of long-term and, as it turns out, usually changing trends in evolution. The literature of that subject is already very extensive and hardly needs exemplification, but fully adequate review and synthesis are still lacking (*33*). A major necessity here is to establish unequivocally that an assembled morphological sequence does truly follow a temporal evolutionary sequence. Former belief in orthogenesis was largely bolstered by ignoring data on time sequence, and the same criticism may justly be leveled at some current work by vertebrate paleontologists of the "pure" morphological school.

The study of evolutionary rates is another complex subject that, in the nature of things, is almost entirely in the province of paleontology. Bader and Kurtén are among those who have made important recent contributions to the subject, in works already cited (*38*, *39*). Still more recently, Kurtén has devised an ingenious half-life method of making quantitative estimates of average rates in whole faunas—a method particularly well adapted to the kind of data now actually available (*40*). With some other problems of rates, such as that of rate distributions within large taxa, a start has been made (*33*) (see Fig. 7), but recent progress has been disappointing because immediately usable data are inadequate, even though such data could be obtained and appropriate methods for analyzing them have already been devised. In all studies of evolutionary rates the greatest present impediment is the inaccuracy of estimates of absolute dates and lapses in time in years. Radioactivity dating is the best method available, but reliable long-half-life dates (for example, from uranium-lead) are still too few and too poorly tied in with fossil faunas, and reliable short-half-life dates (for example, from carbon-14) do not cover enough time. Some recent work, particularly with potassium-argon, does hold out hope for eventual solution of this problem (*41*).

A still more complex whole field of primarily paleontological evolutionary

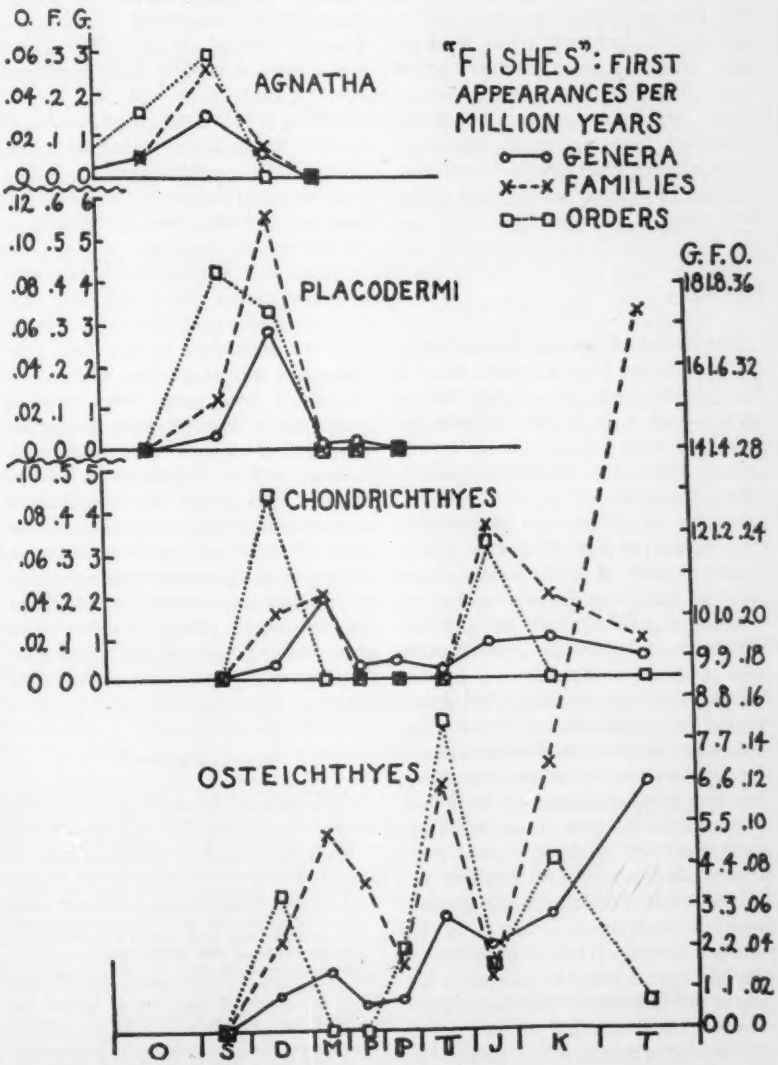

Fig. 7. An aspect of changing rates of evolution in the four classes of primarily aquatic vertebrates (fishes, in a broad sense). The scale along the abscissa, indicating approximate relative durations of geological periods from Ordovician (left) to Tertiary (right), is the same for all four classes. The numbers of known first appearances of orders (*O*), families (*F*), and genera (*G*) are scaled separately for each class on the ordinates. Besides variations in rates of appearances of new groups, successive "explosive" episodes are evident, as well as a tendency for later groups to replace earlier groups.

problems concerns numerous intricately interrelated subjects: the rise of higher taxa and the evolutionary nature of higher categories; their duality of diversification and divergence; the occurrence of "explosive" episodes of diversification; the prevalence of parallel evolution throughout many high taxa and problems of polyphyly arising therefrom; patterns of early radiation in such groups as fishes, therapsids, and rodents. It is perhaps in this general field that vertebrate paleontology faces its most important problems of evolutionary theory and is making (or is capable of making) its greatest contributions to that subject. Even to exemplify these problems adequately and to cite the most important recent work on them would require another article longer than this one. Among other essential problems that can be barely mentioned here is that of extinction, about which a great deal has been written but very little can be said to be firmly known.

Philosophy

The history of life and the processes of its evolution have a crucial bearing on philosophy—on our understanding of ourselves and of the universe in which we live. This is a subject that greatly transcends vertebrate paleontology, but here, too, vertebrate paleontology has or should have an essential role. Its area of main concern is a part of the history of life, and the most pertinent part, since it includes the ancestry of man from jawless fish onward. Vertebrate paleontology also participates with other life sciences, in the elucidation of the processes by which we and the whole world of life evolved.

Among the great philosophical problems on which evolution and, therefore, also vertebrate paleontology bear are those of order in the universe, of utility or teleology, of progress, and of purpose or finality (*33, 42*). Decision on any of those problems must depend largely on what one considers to be the principal directive forces of evolution—whether natural selection (largely a resultant of interaction between organisms and environments), primary action of the environment itself, purely internal forces (especially gross mutations, irrespective of the environment), or metaphysical, nonmaterial, or divine impulses and finalities. One can hardly speak in an absolute sense of proving or disproving any of those views on evidence from vertebrate paleontology, but such evidence certainly bears on which views should be considered more and which less probable.

These questions are always approached on the basis of a priori postulates, seldom frankly stated, often nonscientific and sometimes even antiscientific. In the Soviet Union, purely political postulates forced support of Michurinism, a form of Neo-Lamarckism, even though most Russian biologists knew all the time that accumulated evidence has made that theory extremely improbable. Orthodox Christian, and particularly Roman Catholic, postulates are often, but not necessarily, construed as demanding vitalistic and finalistic control of evolution. Other views inevitably have their overt and covert postulates as well. The important thing is that those postulates should at least be consistent with and appropriate to the scientific approach—otherwise the contribution of vertebrate paleontology or any other life science to philosophy is negatived or stultified from the start. Unfortunately the postulates are not scientific in the most conspicuous recent contribution of a vertebrate paleontologist to this field: the mystical works of the late Teilhard de Chardin, a Jesuit priest, who departed from purely metaphysical postulates and rejected scientific evidence opposed to them (*43*). A few vertebrate paleontologists have spoken for more strictly scientific postulation and inference, but most of them are publicly silent on philosophical questions and probably try to ignore them even in private. They may thereby be losing, by default, the opportunity to explore the most profound problems and values of their subject.

References and Notes

1. Although the number of vertebrate paleontologists in North America is still small, there has been a considerable percentage increase in recent years, and the number continues to rise slowly. In contrast, Lehman estimated in 1957 that the number of vertebrate paleontologists in Europe was then about the same as in 1900. Strictly speaking, there has never been a professional vertebrate paleontologist in Australia, and there is only a handful each in Asia, Africa, and South America.
2. Selection of topics and point of view are necessarily personal, but within the limited scope of this account I have tried to include the interests of others. I have done this largely on the broad basis of years of conversations, correspondence, and exchange of publications. In addition, I have sought explicit advice, in preparing this article, from a small sample of vertebrate paleontologists of varying interests and approaches, including some I might otherwise have missed. Among those who responded to that appeal are R. S. Bader, J. R. Beerbower, B. Kurtén, J. P. Lehman, M. C. McKenna, E. C. Olson, B. Patterson, A. S. Romer, D. E. Savage, B. Schaeffer, J. A. Shotwell, E. Simons, R. A. Stirton, and L. Van Valen. It has not been possible to include all their suggestions, and they are not responsible for the necessary omissions.
3. For a strong but reasonable appeal for emphasis on the morphological approach, see J. P. Lehman, *Bull. muséum natl. d'hist. nat.* (Paris) **29**, 363 (1957).
4. See J. P. Lehman, *L'Évolution des vertébrés inférieurs* (Dunod, Paris, 1959); E. Jarvik, *Théories de l'évolution des vertébrés reconsidérées à la lumière des récentes découvertes sur les vertébrés inférieurs* (Masson, Paris, 1960).
5. F. C. Whitmore, Jr., *U.S. Geol. Surv. Prof. Papers No. 243-H* (1953).
6. R. Zangerl, *Evolution* **2**, 351 (1948).
7. Among many others, see A. S. Brink, *Palaeontol. Africa* **4**, 77 (1957); A. W. Crompton, *Proc. Zool. Soc. London* **130**, 183 (1958); E. C. Olson, *Evolution* **13**, 344 (1959); D. M. S. Watson and A. S. Romer, *Bull. Museum Comp. Zool.* **114**, 37 (1956). Much still unpublished work in this field was reported at Oxford in 1960.
8. Proceedings of the Brussels symposium, which reviewed most of the recent work on the subject, will be published. See also B. Patterson, *Fieldiana. Geol.* **13**, 1 (1956).
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11. B. Schaeffer, *Am. J. Phys. Anthropol.* **8**, 281 (1950).
12. On this and other topics discussed in this section, see G. G. Simpson, *Principles of Animal Taxonomy* (Columbia Univ. Press, New York, 1961); on the statistical principles involved, see G. G. Simpson, A. Roe, R. C. Lewontin, *Quantitative Zoology* (Harcourt, Brace, New York, 1960).
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14. J. A. Shotwell, *Ecology* **39**, 271 (1958).
15. R. W. Wilson, *Univ. Kansas Publs., Paleontol. Contrib., Vertebrata* (1960).
16. For different viewpoints on the problem for Mammalia, see L. Van Valen, *Evolution* **13**, 304 (1960); C. A. Reed, *ibid.* **13**, 314 (1960); G. G. Simpson, *ibid.* **13**, 389 (1960).
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19. J. H. Quinn, *Univ. Texas Publ. No. 5516* (1955). As a matter of principle Quinn used taxonomic methods unacceptable to many of his colleagues, and his conclusions have not been widely adopted, but they certainly indicate that the classic phylogeny of the Equidae must be changed in many details. M. F. Skinner is currently working intensively on this subject.
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34. Although not a paleontologist, Rensch has become the authority on "Cope's law"; see B. Rensch, *Evolution above the Species Level* (Columbia Univ. Press, New York, 1960).
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37. E. C. Olson, in *Evolution after Darwin*, S. Tax, Ed. (Univ. of Chicago Press, Chicago, 1960), vol. 1, p. 523.
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41. D. E. Savage, G. H. Curtis, J. F. Evernden, *Bull. Geol. Soc. Am.* **71**, 1966 (1960) [abstract; full text in press (New York Academy of Sciences)].
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Sounds Emitted by the Bottlenose Dolphin

The audible emissions of captive dolphins under water or in air are remarkably complex and varied.

John C. Lilly and Alice M. Miller

Some of the sonic (audible to human beings) emissions of the bottlenose dolphin of the east coast of the United States (*Tursiops truncatus* Montagu) have been described (*1*). One of the classes of emissions (the clicks) has been studied situationally in the limited context of their use in echo-location (*2–4*). Some of the supersonic components of these clicks have been measured (*2, 3*). In this article we present evidence that the dolphin's audible sonic emissions can be divided into at least three classes: (i) sine-wave type whistles; (ii) slow trains of clicks (buzzings); and (iii) a class of complex waves emitted in bursts (quacks, squawks, blats). It can be shown that these classes of sounds are emitted under different environmental conditions and states of need. It is shown that each animal probably has at least two sound-producing mechanisms available for simultaneous use. The dolphin's now well-known use of click trains (creaking, and so on) as "sonar" is not under discussion here and has been eliminated as far as possible in the experiments (*5*).

The methods of investigation were briefly as follows: A captive animal was restrained and confined in water 10 to 15 inches deep, in a space 15 inches wide and 7.5 feet long, with polyurethane foam 1 inch thick along one side of the water box to attenuate echoes somewhat. (The same animal was also observed and the emissions were checked under conditions in which the dolphin could swim more freely.) A hydrophone, with preamplifier (*6*), was placed beside the animal's beak (rostrum). The animal could not move its head more than 6 inches (one wavelength at 10 kilocycles per second in sea water) from its mean position relative to the hydrophone and walls. The output of the hydrophone was amplified and recorded on a magnetic tape recorder at 60 inches per second (*6*). The pass band of this configuration is determined by the hydrophone (upper limit, about 33 kcy/sec) and a high-pass filter (1 kcy/sec). For analytical purposes, the tape recording was played back (slowed down 8 to 16 times), analyzed electrically, and recorded with an ink writer or a mirror galvanometer oscillograph, or both (*6*).

The sounds recorded were those emitted (i) spontaneously in solitude, or (ii) on hearing sounds of another animal nearby in a similar water box, or (iii) in response to maneuvers on the part of the observer. Most of the findings reported here are based on observations of four animals studied intensively (every day for 3 to 6 months) and of ten others observed for periods of from 24 hours to 6 days.

In solitude an animal emits whistles and clicks and, very rarely, quacks or blats. In response to, and in exchange with, another dolphin at a distance, an animal emits whistles and trains of clicks (at a relatively slow repetition rate) and occasional quacks. In violent play, courtship, and intercourse, in close quarters, each may emit all three classes of sounds, with fairly frequent squawks, quacks, and blats.

The sounds that an observer can elicit from a restrained dolphin can be of any of the three classes, depending on the tactics of the observer. As described previously (*1–4*), placing a fish or any object in the box sets off trains of clicks of a particular kind (creakings). A loud whistle by the observer elicits whistles. Bodily manipulations (gentle to painful) can elicit whistles or quacks or blats. In the presence of an observer an animal can and does shift from emitting sounds under water to emitting sounds in the air, by raising its blowhole out of the water. The whistles in the air are faint and occur at the blowhole slit; they are accompanied by small bubbles, which are lacking in most underwater emissions. To make loud clicks, blats, squawks, and quacks (and other air-borne sounds not here described), the animal opens its blowhole and releases the internally produced sounds into the air.

Simultaneous Clicks and Whistles

Here we present analyses of only the underwater sounds and the underwater sonic components of the air-borne sounds. Figure 1 is a graphic amplitude record (*6*) of simultaneous underwater emission of a slow train of clicks and a whistle. The clicks occurred at a rate

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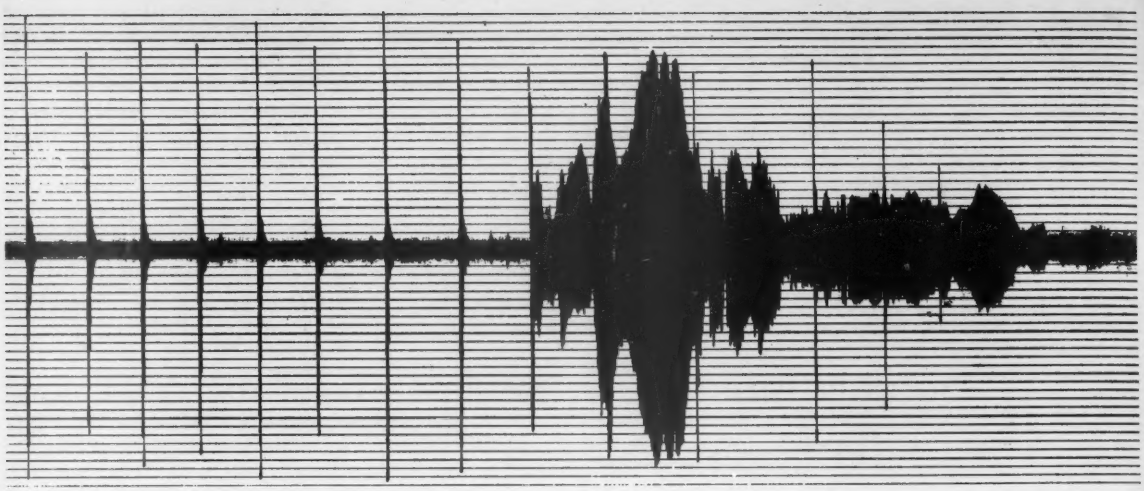

Fig. 1. Amplitude record of a train of clicks and a whistle. Mirror galvanometer (4800 cy/sec) record from a slowed tape recording (1/16 original speed) from an AN/PQM hydrophone set. This record shows the rapid changes in amplitude of the whistle emission and the simultaneous production of clicks during whistling (see Fig. 2, *1A* and *1B*). Records such as this, made with a paper speed ten times that used in making this record, were used in calibrating and standardizing the amplitudes and frequencies, in the preparation of Fig. 2.

of about 30 per second; the whistle lasted 0.3 second. At least five clicks occurred during the whistle. The train of clicks ended during the whistle (in other emissions a train of clicks has been found to start in, to continue beyond, or to stop during a whistle). Notice the rapid changes in amplitude of the whistle. The patterns of such changes are extremely complex, varying markedly from one emission to another; however, in most cases the amplitude (Fig. 2) quickly reaches peak and falls during the rest of the emission. [Some of the quick variations are undoubtedly caused by echoes, standing waves, and interference phenomena in the restraint box, but not by changes in the distance of the head from the hydrophone (*3*)]. Whistle emissions (in a solitary dolphin or in a pair) usually occur in groups of one to four whistles, rarely in groups of five, six, seven, eight, or nine. In a series of 1000 whistles, groupings of two or three whistle emissions were most frequent. Within a group of whistles, each emission is separated from the others by intervals of silence (in a group of eight animals) or by a low-frequency, low-amplitude sound (in the case of a single animal). Each emission lasts from 0.1 to 0.4 second; the most frequent duration is 0.25 second; an emission of 0.1 second is rare. The frequency-time curves for the emissions in a group of whistles resemble one another closely; between one group and another there are larger differences in pattern.

Figure 2 is the record of a group of two emissions. Their graphical amplitudes (*A*) and frequencies (*B*), versus time, as recorded simultaneously from a slowed tape are shown. (The original recording was made at a rate of 60 inches per second; during playback and analysis the recording was slowed to 3¾ inches per second—a 16-fold

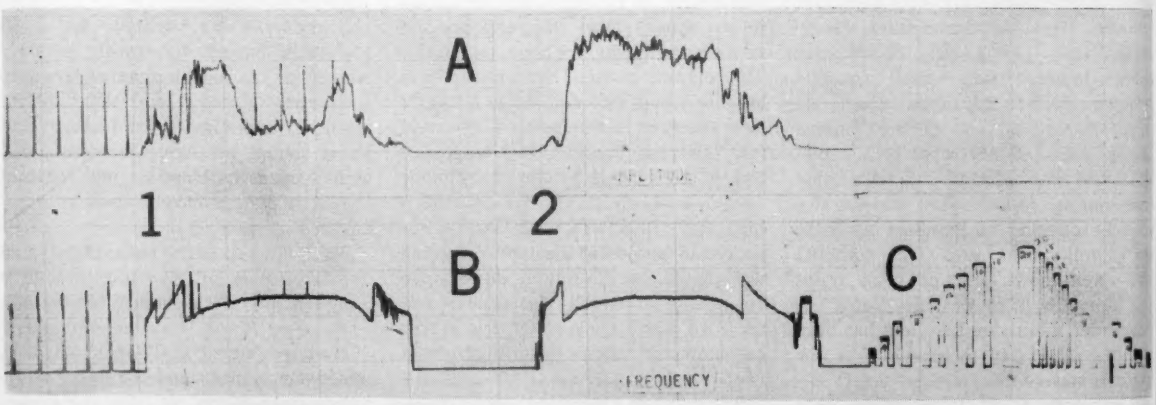

Fig. 2. Records of a train of clicks and two whistle emissions. Trace *A*, amplitude of underwater sound versus time; trace *B*, frequency analyses versus time. *1*, first emission; *2*, second emission; *C*, frequency calibration in steps as follows: 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 kcy/sec. The duration of each emission is about 0.3 second. Notice that the patterns of amplitudes are quite different for emissions *1* and *2*, even though the patterns of frequencies are similar for the two emissions. Notice also that the first whistle emission (*1*, *A* and *B*) starts and continues during a train of clicks.

reduction in speed). There is some compression of the highest amplitudes of emission No. 2. The time-frequency patterns of these two emissions are more similar to one another than either is to patterns of previous or subsequent groups in this series. It is to be noted that, except for the clicks and for instrumental artifacts when the whistle amplitude is low, these whistles are sine-type waves with integral harmonics (1*f*, 2*f*, 3*f*, and so on) and with usually smooth and sometimes abrupt frequency changes of a monotonic nature. The frequencies in one emission can range from 4 to 18 kilocycles per second; the usual emission has frequencies between 9 and 12 kilocycles per second throughout most of its time course. Despite great differences in amplitude (differences at times as great as 100 decibels), the frequency patterns in a long series are surprisingly stable. In a solitary dolphin the emissions become less frequent and quite stereotyped; with pairs of dolphins, the emissions are frequent and quite complex, with alternation between emissions from each animal and with rare overlaps or rare simultaneous emissions (duets).

Such whistles, when played back at one-eighth the original speed, sound something like an air-raid or police siren whose tone shifts or warbles. In general, in the first half of the emission the tone rises; in the second half it may go on rising, level off, fall, or warble in a complex fashion. In a continuous series, each group of two or

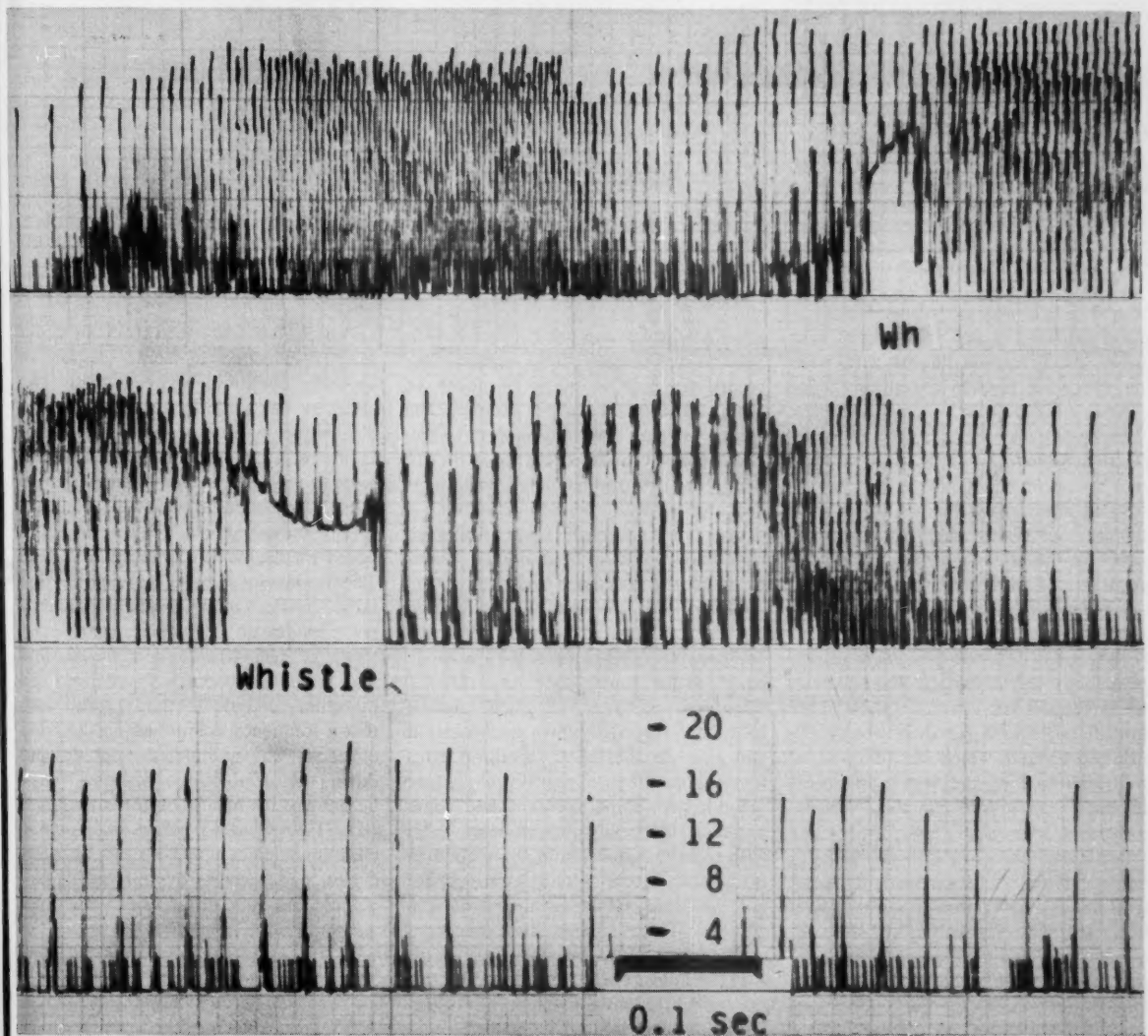

Fig. 3. Record of a squawk emitted under water during stimulation by a human being. The squawk was preceded and followed by a train of clicks at a low rate of repetition (25 to 40 clicks per second). Two whistles occurred during this squawk, one (top trace) at 0.7 and one (middle trace) at 0.95 second after the beginning of the squawk. The frequency calibration (in kilocycles per second) is given, with the time scale (real time), on the bottom trace. A record of frequencies versus time on the sonograph of this same tape shows all of these frequencies, plus others up to at least 64 kcy/sec (see text). Clicks of maximum repetition rates (140 to 400 per second) occurred, in this particular squawk, about 0.82 second after the beginning of the squawk (beginning of middle trace). In other squawks, clicks at rates up to 800 per second have been sustained for as much as 0.5 second. A loud squawk was emitted from the open blowhole in air simultaneously with emission of this squawk under water.

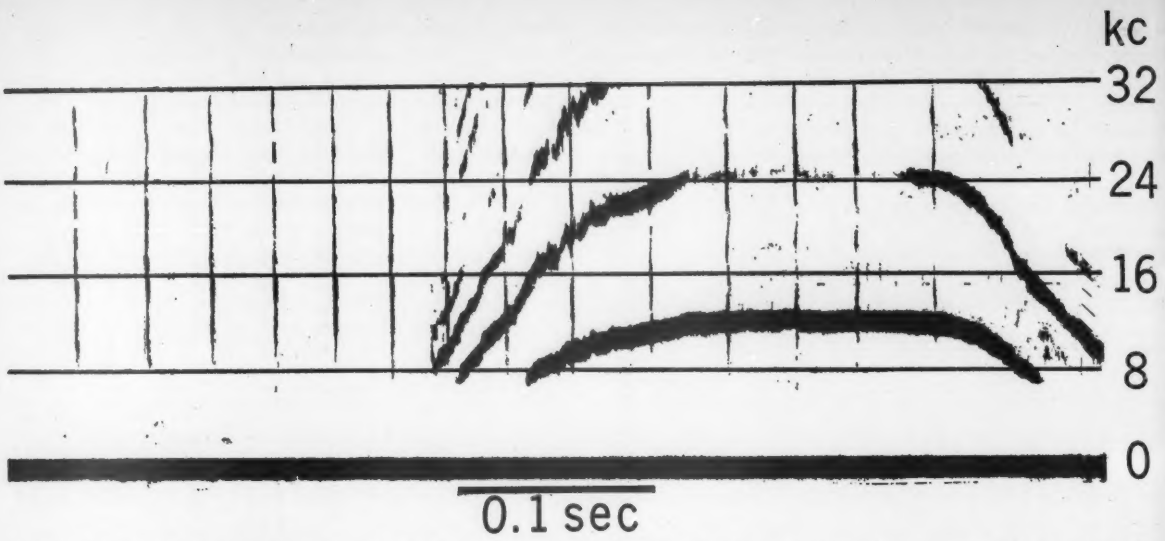

Fig. 4. Sound spectrograph analysis of a whistle and concurrent train of clicks (sonic and supersonic components). The frequencies of the sounds emitted in this sequence extend from about 6 to at least 64 kcy/sec. This figure shows the fundamental, first, and second harmonics, some of the third, and a bit of the fourth up to 32 kcy/sec. The high frequencies have been emphasized in the sonograph. Without such emphasis it can be shown that most of the energy of the whistle lies between 6 and 20 kyc/sec, in the fundamental and first and second harmonics. Similar presentation of other sequences shows peaks for the clicks corresponding to those for the whistles.

three whistles may differ from the group just before or just after it, with the following notable exception.

Distress Signal

If an animal is placed in a distressing situation it will emit two particular dissimilar whistles again and again, as a pair, until relieved by another animal or an observer. The first whistle of the pair is a simple crescendo throughout. The second is a simple decrescendo throughout the emission. The distress signal silences all other dolphins who immediately search for its source. They push an animal which has emitted it to the surface of the water and subsequently carry on complex whistle exchanges with it.

Particular trains of clicks, or "sonar," emitted in echo-location, ranging, recognition, and navigation situations have been described by others (*2–4*). In addition, we find that pairs of animals produce trains of clicks, similar but not identical, under the conditions that evoke whistling and with some of the characteristics of the whistling (Figs. 1 and 2). Sometimes one of the pair puts out a "solo" train, sometimes the two alternate clicks, and rarely they emit clicks simultaneously. When the clicks are slowed down and played back, one can hear that the tones are modified in a systematic fashion not connected with relative movements of the animal. Our recordings include trains of clicks of from 1 to 800 clicks per second. The trains in the slow group (1 to 30 clicks per second) occurred with no need for, or production of, creakings (sonar).

Sounds of class iii (quacks and so on) may possibly be modified trains of clicks at a higher repetition rate, modified with considerable modulation of the middle- and lower-frequency components (components with a range equal to or lower than that of the whistles). Samples of such sounds have been recorded which had constant and also variable click repetition rates from about 50 to about 800 clicks per second, with some constant and some variable frequency components, and with train durations from 0.1 second to 3 or more seconds. The durations are not as predictable as those of the whistles. These sounds, also, occurred without any need for creakings.

It has been observed that whistles can be emitted while class iii sounds are being made (Fig. 3). Such observations demonstrate that the bottlenose dolphin has at least two separately controllable sonic emitters, one for the production of clicks and one for the production of whistles. Study of frequency-time graphs for several hundreds of whistles, individual clicks, and high- and low-speed trains of clicks reveals evidence of some degree of acoustic coupling between these two systems. The sonic [not supersonic (see *3*)] frequency analysis of a click shows it to be a complex wave form with several frequency components, as discussed for sounds of class iii. Figure 2 (*A1*) shows several clicks superimposed on the whistle amplitude record. The frequency curve (*B1*) shows that these clicks contain high-frequency components of frequencies very near those of the whistle and of its first and second harmonics (as determined by other analytic methods), and also that a frequency component in the train of clicks was modulated prior to and during emission of the whistle. It can be shown, by means of the sonograph (*6*) (Fig. 4), that other components, with frequencies up to at least 64 kilocycles per second, are of fixed frequency and vary in intensity with time.

Mechanism

One probable mechanism to explain these results, and similar ones shown in Fig. 3, is that the clicks "shock-excite" the resonant frequencies and harmonics of the air-containing cavities (variable sacs, fixed sinuses, fixed nasal passages, and so on) in the head. One or more of these sacs is used to

produce whistling and can be made to click-resonate briefly during whistling as well as during nonwhistling periods. Because some of the sacs change size and shape through movements of muscles in their walls, the frequencies of the whistle or of the click-excited resonances, or of both, change. The fixed cavities emit their characteristic click-excited frequencies as the coupling and the internal air path are varied. Records on the sonograph (Fig. 4) show these fixed bands better than they can be seen from Figs. 2 and 3. Figure 3 shows the variable components at middle frequencies (less than 22 and more than 2 kcy/sec) better than the sonograph does. During a rapid train of clicks such changes can be detected on the plot of frequency versus time, as shown in Fig. 3.

Analyses of the sounds produced by a pair of severely restrained animals suggest that the whistles are a form of communication, just as some of the slow trains of clicks may be. Rapid trains of clicks (squawks, quacks, and so on) occur most frequently as a result of human intervention, during intense emotional situations such as in courtship and violent play, and during electrical brain stimulation in reward (start) systems but not in punishment (stop) systems (*7*). Thus it appears that trains of clicks express (at least) intense pleasure in various forms, or possibly anger (at times).

That the dolphin has precise and accurate control of these emissions is no longer in doubt. These sounds are classified as vocalizations used for communication. What information is communicated is yet to be determined.

Summary

The sonic emissions of the bottlenose dolphin are remarkably complex. Three classes of these sounds are discussed and presented graphically. The sine-type wave whistles range in frequency from about 4000 to 18,000 cycles per second. The clicks contain components of this same frequency range plus some components of higher frequencies. Complex waves of high amplitude and of many frequencies are also emitted in water or in air. Situations in which sounds of one or more of these classes can be elicited simultaneously from one and from two restrained animals are described. The necessity for, and occurrence of, creakings for purpose of navigation, ranging, and recognition (sonar) have been eliminated in the experiments under discussion.

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6. We wish to thank J. C. Steinburg and Roger Dann of the University of Miami for the use of an AN/PQM hydrophone set; Herbert Gentry (Precision Instrument Co.) for the use of a tape recorder; William Murphy (Cordis, Inc.) for the use of a Massa graphic recorder; and F. G. Walton Smith (Marine Laboratory, University of Miami) for past use of laboratory space. The frequency analyzer used in this study was devised by one of us (J.C.L.). We wish to thank K. N. Stevens (Massachusetts Institute of Technology) for his help and for the use of a sonograph (Kay Electric Co., Pinebrook, N.J.). The mirror galvanometer oscillograph is a Minneapolis-Honeywell Heiland Model 906-B with M-8000 galvanometers. We also wish to thank William Rolleston and F. G. Wood, Jr., for supplying dolphins in the early stages of the work.

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Science in the News

In the Senate: The Debate on Education; The Internal Security Committee Studies Disarmament

The Senate has been involved in an elaborate debate over the school bill since Tuesday of last week (16 May) and will probably still be at it when this appears. Senator Morse, the floor manager for the bill, made it clear that he felt he had enough votes to defeat any amendment opposed by the Administration. If anything, this encouraged the amenders, who could then propose whatever came to mind without having to worry about its consequences, since there was no chance of its being adopted.

Senator Blakely, a very conservative Texas Democrat, suggested simply rebating to each state 5 percent of all the income taxes collected within each state, a proposal that would cost the federal government about $3 billion a year, something over 3 times as much as the Administration bill. Senator Cotton, a conservative Republican of New Hampshire, suggested granting the states 3 cents for each pack of cigarettes sold within the state. Senator Proxmire, a liberal Democrat of Wisconsin, wanted to eliminate the words "federal grants" from the bill and substitute "income tax sharing." Senator Bush, of Connecticut, offered a Powell-type amendment, prohibiting aid to segregated schools, and Senator Thurmond, of South Carolina, offered a Powell-type amendment in reverse, prohibiting the Administration from holding up aid to segregated schools. Cooper, of Kentucky, and Javits, of New York, liberal Republicans, asked for changes in the formula for allocating the grants among the richer and poorer states.

The first week of the debate was occupied with these proposals, all of which were easily defeated, and of which only the Cooper-Javits amendment seemed to be taken very seriously. Senator Goldwater, who voted against loans for private schools last year, then proposed loans for private schools. Senator Talmadge offered a more generally worded version of Senator Thurmond's counter-Powell amendment. Senator Dirksen, with the martyr-like air that has been coming over him lately, proposed cutting the bill back to construction grants only, although he assured the Senate

that he knew perfectly well the suggestion would be declined.

In due course, these, and various other proposals, were expected to be voted down; the bill would pass; and attention would shift back to the House, where the real battle would be fought, with the outcome very much in doubt. Last year, the Senate passed an aid-to-education bill substantially the same as the one being debated now, with nothing like the protracted debate that is going on this year. The entire issue was disposed of in just over 2 days of debate. What is causing the long struggle this year is the knowledge that this may well be the last stand of the opponents of federal aid to education. Last year everyone knew that the only bill that stood a fair chance of passing the House, and any chance of avoiding a Presidential veto, would be a bill limited to a temporary program of construction assistance to meet the classroom shortage.

Technically, the current program is also temporary: it will run for only 3 years. But since it includes grants for teachers' salaries, and so is designed to meet a permanent need, rather than a temporary need like the classroom shortage, the program, for all practical purposes, involves a permanent recognition that the federal government has a legitimate role to play in the support of the public schools. The extent of the role will be a matter of continuing debate, but if the Administration bill becomes law it is doubtful that the basic principle of federal aid will ever again be seriously challenged.

Pugwash Conferences

Elsewhere in the Senate, the staff of the Internal Security Subcommittee, the Senate equivalent of the Un-American Activities Committee, has completed a study of the Pugwash conferences on disarmament. The study will be made public this Sunday.

The conferences were begun in 1957 under the sponsorship of Cyrus Eaton, the controversial Cleveland industrialist, and take their name from the location of Eaton's summer home in Nova Scotia, where the first of the conferences was held.

The most recent of the conferences, which consist of informal discussions of disarmament, primarily among American and Russian scientists, was held in Moscow last December. The next is scheduled for Aspen, Colorado, in mid-September.

The makeup of the conferences has changed over the years. The scientists involved now consist almost entirely of men close to the policy-making levels of their nations, and the meetings have taken on a semiofficial character. The Soviet delegation last December included all the members of the presidium of the Academy of the Sciences and two of the leading military theorists. The American delegation included Jerome Wiesner, now Special Assistant to the President for Science and Technology, and W. W. Rostow, now Deputy Assistant to the President for National Security Affairs, and a number of other nationally known figures, including members of the President's Science Advisory Committee. Cyrus Eaton no longer has any connection with the conferences, which have been renamed the Conference on Science and World Affairs.

The Senate Internal Security Subcommittee is chaired by Senator Eastland of Mississippi, who is also chairman of the full Senate Judiciary Committee. Most of the day-to-day work of the subcommittee is under the supervision of Senator Dodd, of Connecticut, who has served as acting chairman at most recent hearings. Senator Dodd has been one of the most outspoken critics of the nuclear test ban negotiations and, last year, of the treaty demilitarizing and internationalizing the continent of Antarctica.

Dodd has been scrupulous in avoiding the sort of broad charges that made Senator McCarthy such a controversial figure. He and the committee have been careful to avoid suggesting that the groups or individuals investigated are in any way disloyal. Where groups favoring disarmament have been concerned he has seen his role as exposing the extent to which communists and communist sympathizers have been active in the movements, which he feels is both a service to the groups involved, in helping them to keep communist influence out of their movements, and a service to the country in making clear the extent to which loyal, well-meaning citizens may be unknowingly paralleling the Soviet propaganda line.

Although the committee has been scrupulous about making charges of disloyalty, it has been considerably less scrupulous about giving a hearing to all sides of a question. It published the testimony, taken in closed hearings, of the two ambassadors to Cuba preceding the fall of Batista, along with a report accepting at face value their charges that Cuba was pretty much handed over to Castro and the communists through the failure of underlings in the State Department to listen to the ambassadors' reports of what was going on. It did not see fit to hear the men accused of selling out Cuba.

The study of the Pugwash conferences is necessarily the most delicate the committee has handled, involving as it does two of the President's closest advisers and a number of other scientists regularly called on to advise the government on technical questions affecting major policy decisions. The report, consequently, is expected to be doubly careful about avoiding questioning the loyalty of the people who attend the conferences. On the other hand, it is expected to include an extensive review of the activities of such figures as Eaton and Bertrand Russell, who have been involved at one stage or another in the conferences, and who are susceptible to charges of political naivete; to stress the fact that although the Americans have been participating as private individuals, there is no such thing as a private individual in this sense in Russia, and that the participation of Soviet scientists necessarily means that the Soviet government finds the conference in its interest; and to provide documentation for the view that the Russians have been using the conferences as part of their propaganda "peace offensive."

The report is based mainly on the early conferences. The most recent conference, in December 1960, took place while the report was in preparation, and will be treated separately. But the report apparently will not attach much significance to the dropping of Eaton's sponsorship and the changes in the makeup of the delegations.

The report is expected to stress such points as that many of the Soviet delegates were members of the Communist Party; that the American delegates, in the view of the committee, were politically unsophisticated; that the Soviet delegation used the conferences to try to indoctrinate the Americans with their point of view; and that the proceedings of the conferences, although not made public, were made available to Soviet Premier Khrushchev.

Many of the charges, of course, would apply to Soviet-American contacts generally. The verbatim transcript of the Kennedy-Khrushchev meeting will be available to Premier Khru-

shchev; the intention of Premier Khrushchev will be to try to impress the Soviet point of view on the President; and Khrushchev is well known to be a member of the Communist Party.

The criticisms, then, only take on significance on the assumption that the American scientists are babes in the woods dealing with the shrewdly calculating Russians. The report apparently will suggest that a major Soviet interest in the conferences is to weaken the will of American scientists to resist Soviet aggression, and possibly to seduce the scientists, who, the report will apparently imply, are especially susceptible to such seduction, to actual subversion.

The report apparently will avoid even mentioning the connections of members of the American delegation with their government, and thus will avoid explicitly raising such questions as whether the President himself was unwittingly aiding the communists when, as President elect, he permitted Jerome Wiesner and W. W. Rostow, two of his closest advisers, to attend the conference, or whether the President, lacking the subcommittee's understanding of the nature of the communist conspiracy, has been looking for advice from men who are easily taken in by the Russians. But it is not difficult to guess that others will not be slow in picking up where the subcommittee leaves off, and the question then arises: If the President has chosen such men as advisers on the extremely delicate matter of disarmament, whether other presidential advisers are not equally open to question.

Other policies quickly come to mind as almost equally unpalatable to a good many people as taking seriously the Russians' claims of interest in disarmament: the view, for example, that American foreign aid commitments should be conditioned on a nation's willingness to go through with social and political reforms more than on its willingness to adhere to pro-American military alliances.

Thus, although the report apparently will concentrate its fire on such easy targets as Cyrus Eaton and Bertrand Russell, its implications, by no very indirect route, lead to the highest levels of the Administration, and it is difficult to see how the view reflected in the report can avoid, sooner or later, requiring an answer by anyone of lesser stature than the President himself—H.M.

Announcements

A **Russian drug index**, containing a comprehensive listing of drugs currently in use in the Soviet Union for therapeutical and experimental purposes, has been published by the National Library of Medicine. The index (PHS Publication No. 814) is designed to "overcome obstacles to understanding Russian scientific literature presented by the language barriers, since Russian drug names often have no relation to the generally accepted names used for medical purposes in other parts of the world." (Superintendent of Documents, GPO, Washington 25, D.C. $.60)

Meetings

The Inter-American Conference on **mathematical education**, under the direction of the International Commission on Mathematical Education and the Organization of American States, will be held in Bogotá, Colombia from 4 to 9 December. The conference will cover the present status of mathematical education at the secondary and university levels in each of the countries, the needs for improved mathematical instruction, and procedures each country can initiate to progress in mathematics, especially in preparing teachers and research workers. Attendance will be limited to invited participants and persons sent as delegates from their governments, scientific organizations, and sponsoring bodies. The conference was made possible by grants from the Ford Foundation, UNESCO, OAS, and the Colombia Government.

An international symposium on **microchemical techniques**, conducted by Pennsylvania State University's College of Chemistry and Physics and Continuing Education, will be held from 13 to 18 August. Subjects for technical sessions will include organic and inorganic chemistry, organic functional groups, microscopy, microsynthesis, microphysical methods, instrumentation, titrimetry, microbiochemistry, nucleonic methods, trace analysis, and general topics. (Pennsylvania State University, University Park.)

The 7th Inter-American Congress of Psychology will be held in Monterrey, Mexico, from 19 to 23 December. Papers on the understanding of human behavior in cross-cultural situations are being solicited from members of any of the **behavioral sciences**. The congress will be organized under the main headings of personality and culture, experimental psychology, applied psychology (educational and industrial), and psychology and mental health. It is being held under the joint auspices of the Instituto Tecnológico y de Estudios Superiores de Monterrey, the Institute of Latin American Studies of the University of Texas, and the Centro de Investigaciones Sociales, with headquarters in Monterrey. Abstracts of papers must be submitted in duplicate *prior to 1 August*. (Centro de Investigaciones Sociales, Box 7553, University of Texas, Austin 12)

Courses

A 2-week course on the application of **nuclear methods to oceanography** and related fields will be conducted by the Oak Ridge Institute of Nuclear Studies 6–17 November. The course, conducted by the institute for the U.S. Atomic Energy Commission, will be limited to 20 participants. Deadline for return of applications is *1 August*. (Ralph T. Overman, ORINS, P.O. Box 117, Oak Ridge, Tenn.)

An extensive research training program in **obstetrics and gynecology**, established with a grant from the Public Health Service, will begin on 1 July at the University of Oregon Medical School. The program, designed for training of undergraduate, graduate, and postgraduate students, will emphasize basic and applied cancer research. Student trainees will be provided with a 3-year stipend, and will receive a master's degree as well as a doctor of medicine degree on completion of the program. Postgraduate trainees during a 4-year residency program will receive salaries in excess of the regular resident stipends. Postresidency trainees will receive stipends comparable with those of beginning private practice. (University of Oregon Medical School, Portland 1)

The American Oil Chemists' Society is offering a short course on **newer lipid analyses** for organic and physical chemists and biochemists, to be held at the University of Rochester 24–26 July. The closing date for registration is *13 July*. (American Oil Chemists' Society, 35 E. Wacker Dr., Chicago 1)

Grants, Fellowships, and Awards

Grants-in-aid are available, through the Herman Frasch Foundation, for fundamental research in **agricultural chemistry** at nonprofit, incorporated institutions. The grants, made for periods up to 5 years, are subject to annual review and approval on evidence of satisfactory progress. Applications should be submitted *before 1 July* and should contain the following information: outline of the research project; potential practical benefit of results; facilities available; qualifications of available personnel; anticipated time for completion; itemized estimate of annual expenditures for salaries, supplies, equipment, and so forth; and publication plans. The grants are administered by the United States Trust Company of New York, with the advice of the American Chemical Society. (Earl A. Samson, Jr., United States Trust Co., New York, 45 Wall St., New York 5)

Fellowships and research grants in the studies of **hemorrhagic disorders** are being offered by the National Hemophilia Foundation. The foundation is primarily interested in pilot projects that would not be eligible for support by the National Institutes of Health. (Martin C. Rosenthal, National Hemophilia Foundation, 175 5th Ave., New York 10)

Over 200 fellowships for **graduate study** in 15 foreign countries in 1962–63 are being offered by foreign governments and universities through the Institute of International Education. The fellowships cover tuition costs and provide various amounts for living expenses. Students applying for Australian, Danish, French, German, Israeli, Italian, or Netherlands government awards may apply for a Fulbright travel grant to supplement the fellowship. Eligibility requirements include U.S. citizenship, a bachelor's degree or its equivalent before departure, and ability to speak the language of the country that is offering the fellowship. Preference is given to applicants under 35 who have not had extensive experience abroad. Two additional awards, for study or research in any country in the Far East, South or Southeast Asia, or Africa, are being offered by an American foundation. (Information and Counseling Division, Institute of International Education, 1 E. 67th St., New York 21)

Scientists in the News

LeRoy E. Burney, former surgeon general of the U.S. Public Health Service, has been appointed to the newly created position of vice president for the health sciences at Temple University Medical Center.

Frank Press, professor of geophysics at the California Institute of Technology, has been named California scientist of the year by the California Museum of Science and Industry Foundation. The annual award carries a prize of $5000.

Jay H. Davidson, chief of Haverford Hospital's department of medicine and faculty member of the Graduate School of Medicine, University of Pennsylvania, has been appointed director of medical education at St. Luke's and Children's Medical Center, Philadelphia.

David S. Stoller, a member of the logistics department, Rand Corporation, and acting assistant professor of business administration at the University of California (Los Angeles), has been appointed a visiting consultant in operations research by the NATO Scientific Council for the academic year 1960–61. He will hold a joint appointment as a consultant with the Italian Government's Central Institute of Statistics and as a visiting professor at the University of Rome.

William Grove, associate professor of surgery at the University of Illinois, has been named associate dean of the university's college of medicine. He succeeds **William F. Kellow**, who resigned his position to become dean and chief medical officer of the Hahnemann Medical College.

Oscar K. Diamond, psychiatrist and former assistant director, Creedmoor State Hospital, Jamaica, N.Y., has been appointed director of Manhattan State Hospital, Ward's Island, N.Y.

Two faculty members of Ohio State University College of Medicine have been promoted to assistant deans, effective 1 July. **John A. Prior**, professor of medicine and chief of the division of pulmonary diseases at University Hospital, succeeds **N. Paul Hudson**, who will retire on 30 June. **James H. Williams**, clinical assistant professor of obstetrics and gynecology, succeeds **Chauncey D. Leake**. Leake, currently president of the AAAS, will continue as professor and chief of the division of pharmacology.

James L. Dyson, head of the geology department at Lafayette College, has been elected president of the Pennsylvania Academy of Science for the year 1961–62.

David D. Daly, consultant in neurology, and **James W. Kernohan**, senior consultant in pathology, Mayo Clinic, have joined the staff of the Barrow Neurological Institute, Phoenix, Ariz. Daly will become chairman of the division of neurology, and Kernohan will become chairman of the division of neuropathology.

Leon I. Goldberg, clinical associate in experimental therapeutics with the National Heart Institute, has been appointed associate professor of pharmacology and assistant professor of medicine at Emory University.

Robert B. Reed, associate professor of biostatistics in the Harvard School of Public Health, has been named professor and head of the department, effective 1 July. He succeeds **Hugo Muench**, who will retire at the close of the current academic year.

Sir **Harold Roxbee Cox** has been appointed chairman of the Council for Scientific and Industrial Research, Department of Scientific and Industrial Research, London, for a 5-year term. He was previously chairman of the Metal Box Co., Ltd., and is chairman of the National Council for Technological Awards.

Two National Bureau of Standards scientists have been selected to be the Bureau's first senior research fellows. **Ugo Fano**, former chief of the radiation physics section, and **Herbert Broida**, solid state physicist, will be afforded an opportunity to conduct individual research not falling primarily within the scope of a particular scientific division at the Bureau.

Herbert Friedman has been appointed part-time professor of physics at the University of Maryland. He is currently superintendent of the astrophysics division, Naval Research Laboratory, Washington, D.C.

Book Reviews

Man Takes Control: Cultural Development and American Aid. Charles J. Erasmus. University of Minnesota Press, Minneapolis, 1961. viii + 365 pp. $6.50.

The United States has tried and continues to try to "do good" for underdeveloped areas of the world by providing technical aid and assistance. This effort began considerably before similar efforts began on the part of the Soviet bloc, and its impact in terms of dollars is still much larger. Yet, even before Soviet bloc competition was significant, the results of United States "technical aid" among the less modernized peoples were often disappointing or questionable. And now, in the current perspective of "cold" or "peaceful" warfare, such failures or equivocations take on the color of serious defeats.

Many social scientists of the type trained to get out among the common people in foreign areas rather than to rely merely on official statements and reports have observed and commented upon the deficiencies of some of the technical aid programs. But their opinions have been little heeded and less sought after in policy circles. For years Washington planners and administrators told us that such programs did not need "impractical dreamers" or "so-called" experts in "intangibles." If we are going to help an undeveloped country improve its agricultural production or sanitation, for example, so the line went, we should send hardheaded experts in such matters and not bother about difficult-to-understand affairs like the natives' value systems or social organizations. If the natives cannot see the obvious advantages of the new hybrid food plants we send them or if they cannot understand anything so simple as the necessity for boiling water to destroy intestinal parasites, there obviously is "something wrong with them" and they deserve the troubles which the United States is so generously trying to eliminate through the application of its technical knowledge and skill. Political opponents of the administrations in power have not, of course, been loath to advocate that the whole foreign aid program should be dropped because some failures have shown a considerable waste of the taxpayers' money.

Causes of Failure

Many behavioral scientists who have listened to such discussions in Washington and who have observed the programs abroad have felt differently. The trouble has been, they thought they knew, that many foreign aid programs fell somewhat short of total success because they employed only a part of the scientific knowledge and "technology" which was at the United States' disposal and which was necessary for success. We may send extremely competent engineers to help install a steel mill in Latin America, but after it is installed, Latin American people will have to work in it and the society in which it operates will have to adjust to it. Likewise with expertise in health, agriculture, transportation, housing, mining, fishing, and so on.

This book is mainly devoted to such matters, and I hope that it will be widely read by persons engaged in foreign aid programs, although it may prove hard going for some. For example, Erasmus writes: "While physical scientists seem to reach a consensus about the weaknesses or strengths of a paper fairly rapidly . . . . social scientists evince strong ego-involvements in their vocabulary and will argue their definitional differences into the ground. Novelty in the social sciences depends more on fresh analogies and jargon than on new frequency interpretations" (page 313). Erasmus occasionally proves himself to be, in this sense, a true social scientist, despite the fact that he writes many passages in clear, plain English. Incidentally, he borrowed the term *frequency interpretation* from philosopher Hans Reichenbach, and he uses it constantly. It means "how followers of a given culture see a given phenomenon." The author has also permitted himself a few hasty slips. For example, "Culture consists of *all* behavior acquired by men as members of social groups" (page 103, italics mine). I am sure he would agree that practically all normal members of social groups acquire idiosyncratic behaviors which are not shared and therefore are not a part of culture.

Planned Sociocultural Change

However, permit me, at the risk of oversimplification, to point to a few aspects of the book that may well prove rewarding to policy planners, foreign aid field men, and social scientists. About two-thirds of the volume is given over to a cultural theory related to planned sociocultural change in underdeveloped areas. The function of any given culture, the author says, is to offer some means of satisfying felt needs or wishes. Erasmus deals with only three types of such desires: hunger, sex, and prestige. And most of his argument has to do with prestige. He repeats what has long been an accepted part of general cultural theory —namely that such wishes or needs are uniquely defined in each culture, unless it has borrowed from elsewhere, and so are the means for satisfying them. And he stresses that the definitions of need, the means for satisfying it, and the goals sought may all be changed in time and by inside and outside influence. He roundly rejects "cultural determinism" of a type that allows no influence to individual or environmental (including social) factors. I am not aware that such a concept of "cultural determinism" has been seriously held by influential cultural theorists during the past 25 years, but Erasmus' emphasis is essential to his theoretical deductions.

Culture, he says, correctly I believe, includes not only means and modes of satisfying wants, but also patterns of cognition, "frequency interpretations," and notions of differences between the members or groups of a society which lead to "invidious emulation" and "invidious sanction." He then suggests, with many illustrations from the literature and his own observations, that with respect to the prestige motivation at least three sociocultural types may be

distinguished. In closed societies (for example, the Haida) conspicuous giving is the pattern for prestige; conspicuous ownership (for example, in Western capitalist societies until recently) confers distinction in the "opening society"; and finally, conspicuous production has become the prestige rule in modern societies. However, the latter are of two types: coercive (in Soviet Russia) and free (in the United States). The author has some quite intriguing things to say, against a background of cross-cultural survey, about the decline of conspicuous consumption and the turn toward production as a measure of a person's worth in our own society.

Facts of Revolution

The final third of the book consists of an analysis of a mutual aid program in Sonora, Mexico, financed in part on a supposedly self-liquidating basis by the United States and planned and carried out mainly by Mexican technical specialists with some aid from the United States and other outside sources. Erasmus points out that when the projects began, the Sonora area was a "dual society" consisting of lower-class elements (both Indian and mestizo) and a sort of upper class, with very insignificant middle elements. (I am again oversimplifying.) However, two results must be considered (not necessarily accepted, without further study, as universally occurring) by North American "do-gooders." First, the land reform program resulted in the carving up of several large parcels and in its redistribution in small lots to peasants. But within a few years many of the small lots were regrouped into larger holdings, mainly in the hands of the "new rich" upper or upper middle class, who had been able to help out their poor brethren with unrepayable loans. Second, graft (*mordida*) undermined many of the government's and social planners' fine plans. Erasmus thinks that, given the Mexican situation for what it was and perhaps still is, this is not such a bad thing after all. The grafters reinvested their graft to the over-all economic and social good of the community. He suggests that as the middle class grows and becomes more socially conscious graft will recede. I am afraid social planners in the United States must take some of these mundane facts of life into consideration. Graft and power-seeking are going to take various forms in different parts of the world. This year we have had reports of something similar that occurred in the Soviet Union with respect to socialized agriculture and of Khrushchev's reactions thereto. What will happen to land reform in Cuba? And as for "conspicuous production," what is the meaning of the recent revelations regarding price fixing in our own electrical industry?

Erasmus has been out among the common people, in Mexico, Haiti, Ecuador, Colombia, Peru, Chile, and other places. In this respect there are many others like him in the United States. But their experience and knowledge are not used by the national government. We hear a good deal about social science professors from Harvard and Massachusetts Institute of Technology who have been called to Washington. They are needed, but few have made a career of working among ordinary, common, lower-class people in underdeveloped areas, the kind of people that are going to support social revolutions if they themselves do not lead them. Perhaps some of the sort of scientific talent of which I speak is needed in the present cold war. Its lack surely seems to have been indicated in the recent Cuban fiasco.

JOHN GILLIN

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The Affair. C. P. Snow. Scribner, New York, 1960. x + 374 pp. $4.50.

The Affair is the eighth in C. P. Snow's series of novels entitled "Strangers and Brothers," after the first novel of the series. It is closely related in substance to *The Masters*, which it is supposed to follow after the passage of 16 years. The story is told in the first person by Lewis Eliot, lawyer and government administrator, and revolves about a problem of justice arising in one of the colleges of Cambridge University. One of the younger scientists of the college, Donald Howard, a man generally disliked for his leftist views and his lack of good manners, or perhaps disliked simply because he did not belong to the usual social class of university people, has been dismissed because of a verdict of scientific forgery. In his major scientific work, published jointly with his old master, Palairet, and constituting the principal basis of his appointment as a fellow of the college, a photograph has been found to be an obvious fakery.

"The affair" arises when a number of members of the college become convinced that Howard is actually innocent, and that the forgery was committed, for undisclosed reasons, by the eminent old scientist Palairet, since deceased. The campaign to reopen the case is strongly opposed by those who feel that Howard is not quite up to the college's standards anyway, that the scandal would do the college great injury, and that the best policy is to let the whole thing rest. The motives of the participants in the wrangle are considerably beclouded by the imminent election of a new Master of the College, a post to which several of the persons involved have aspirations. The denouement hinges on the development of evidence, quite convincing but never admitted, that the bursar of the college has suppressed the critical evidence that would have implicated Palairet and have vindicated Howard.

The slowly developing plot brings out to the fullest the psychological twists and turnings of each of the major characters, as viewed through the anatomical vision of Lewis Eliot. Moving deliberately, as befits a college atmosphere, the tale after some 200 pages really becomes absorbing; and the ultimate delineation of the courage and moral principle of Francis Getliffe, the eminent scientist who risks his chance to obtain the coveted post of Master of the College by defending Howard's innocence and by insisting on the need for the college to make retribution, is graphic and moving. The strength of the novel, as in *The Masters*, lies in Snow's ability to deal with human motives and psychological problems. Its weaknesses are those already marked in previous Snow novels: the shadowy character of his females and the exclusively intellectual level on which his protagonists seem to live. It is also peculiar to meet with a college which seems to have no students, so vaguely do they figure in the background.

Moreover, certain critical matters are left somewhat unsatisfactory. The motivation of Palairet to commit a fraud at the close of a scientific career of solid eminence rests unexplained; and the peculiar schizoid behavior of the bursar, who commits a fraud to prevent disgrace to his college from public knowledge that an acknowledged fraud had been found to be attributable to a

person other than the one previously condemned for it, surely requires greater elucidation. To an American it seems at least peculiar that members of a great English college would not generally assume that any damage done to the reputation of an institution rests more on the attitude of the institution in its treatment of individual offenses and on its defense of academic freedom and justice than on the circumstance, which now and then must occur in the best-ordered families, that a black sheep has turned up. To an American, also, the great desirability of the mastership of a Cambridge college seems an incongruously weak motive for a Nobel prize winner in physics, a man with dozens of international honors as well as knighthood and complete security in his university professorship. Yet undoubtedly people are like that, made of mixed, incongruous, unsuspectedly complex motives—and if Snow leaves some elements unexplained, that fact may well be covered by the device of a first-person narrative, since what person understands fully all of the reasons for his fellows' actions?

I cannot agree with certain other reviewers who have seen in this novel a reflection of Snow's preoccupation with the "Two Cultures," with the inability of men of science to communicate with those of the humanities, and vice versa, even about matters of great import in their respective fields. This cleavage is present, but remains strictly in the background of "the affair." Here everything centers upon the simple struggle for justice to a man who is disliked and virtually friendless, but who has been the victim of a miscarriage of justice. Youth versus seniority, the sciences versus the humanities, liberalism versus conservatism alike fade into minor significance in the struggle that develops. The chief defenders of justice are young Tom Orbell in English, Skeffington, a physicist, Francis Getliffe, also a physicist, and of course Lewis Eliot, who as legal adviser and ex-fellow of the college, plays a major role in securing the reconsideration by the Court of Seniors.

As a novel of science, or a novel about scientists *qua* scientists, *The Affair* might be compared with Eleazar Lipsky's recent novel *The Scientists.* Both novels deal with scientific fraud and its effects upon the lives of the accused, their friends, their families, and their enemies. In certain respects each novel bests the other. Where Snow's story excels is in its subtle delineation of character and in the portrayal of the intricate internal politics of an English college. It is somehow comforting to know that all the offenses against academic freedom and justice, and all the campus intrigue and scandal, are not limited to our side of the water. And how characteristic that when justice is done, it is done reluctantly and in less than full measure.

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Handbook of Research Methods in Child Development. Paul H. Mussen, Ed. Wiley, New York, 1960. 1061 pp. Illus. $15.25.

Twenty-two chapters prepared by authorities survey the techniques that have been used to study the child from infancy to adolescence. Studies of behavior predominate, but physical growth, chemical and physiological growth, and the anthropological perspective receive one chapter each. The typical chapter offers a historical sketch of old and new methods, abstracts of studies illustrating methodological variations, and some caveats regarding shortcomings of the prominent techniques. The beginning graduate student will find here a veritable museum display of ways to gather and codify data. More than that, he is coached in the tactical lore that rarely gets into print: how to obtain permission to use a child as subject, for example. The handbook will undoubtedly become a standard source in graduate training.

To the established professional, it offers less. He can obtain an overview of current methods in a field outside his experience, but will rarely find a new perspective on the field he knows. Among those chapters which merit attention from well-trained workers, that of Eleanor Gibson and Vivian Olum on studies of perception stands out for its sympathetically critical presentation of little-known work, and that of W. W. Lambert stands out for its provocative questions about the strategy of research and the interplay between theory and choice of method.

A handbook such as this is a labor of love for its authors and editor, and one hesitates to be adversely critical when the volume is serviceable and sound. Yet a reviewer must speak of excessive duplication between chapters, occasional breathless cataloging, and space misspent on truisms and worse. ("Compared with the living child, the child cadaver has methodologic advantages from being more rigid, more amenable to anatomic study, and more permanent . . . [but it] cannot be regarded as a source for longitudinal records.")

The troubles of this volume arise chiefly because there are no "research methods in child development." The methods are neither more nor less than the methods of half a dozen sciences, and hence not adequately to be treated in one volume. The unique aspect of research on children is the methods one is prohibited from using: the pure-strain subjects he cannot purchase, the complex directions he cannot communicate, the shocks he cannot administer, and so on. In this volume, it is easier to see why developmental research has disappointed the hopes of a generation ago than to see wherein it will find unity and direction.

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The Golden Age of American Anthropology. Margaret Mead and Ruth L. Bunzel, Eds. Braziller, New York, 1960. x + 630 pp. $10.

This large book consists almost entirely of reprints of published articles written by the founders and masters of American anthropology, epitomizing the development of American thought on that science. With the exception of some of the earliest sources and of two Russian anthropologists whose field was northeastern Siberia, all of the authors are—or were—American citizens who wrote on the American Indian, and almost exclusively on those living north of Mexico. The 45 authors of the 65 selections include, of course, all the great names and a number of little-known ones, such as John Bachman and Manasseh Cutler; however, one misses a few men, such as B. L. Whorf, who made major contributions to anthropological theory. All of the articles are of course short; generally they are excerpts from larger works, often not the author's best-known one, but they are always characteristic. The book is an excellent compendium.

While the "Golden Age" is defined

as the period from 1880 to 1920, the selections span a much longer time—from Bernal Diaz, Sahagun, and Jefferson to Spier. These are divided chronologically into six periods, from "Exploring the New World" to "New Horizons," and the intermediate periods are given such terms as "Gaining Understanding of the Indians." The authors are furthermore grouped under such titles as "Dedicated Amateurs" and "The United States National Museum."

In the printed matter the senior editor, Margaret Mead, contributed only the main introduction, but the introductions to each of the six parts and the many and full biographical accounts of the authors as well as the historical backgrounds of their periods, by Ruth Bunzel, are delightfully written, with insight, empathy, and knowledge, based on her long experience in the field and her acquaintance with most of the later contributors.

The only mistake that I found is a trivial one (page 155): Bulletin 30 of the Bureau of American Ethnology is the great *Handbook of American Indians*, not that of American Indian *Languages*. And it is not—though generally believed by others—Mormon creed that our Indians are descendants of the lost tribes of Israel.

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The Orion Book of Evolution. Jean Rostand (translated from *L'Évolution* by Rebecca Abramson). Orion Press, New York, 1961. 105 pp. Illus. $6.95.

In this publication two quite separate small books have been shuffled and bound together: an essay on evolution and an album of pictures. Any relationship between the two is not merely coincidental; it is nonexistent.

Rostand's background in French literature and philosophy gives his essay some freshness and interest for American readers, but unfortunately the essay cannot otherwise be highly recommended. The first section, on the history of evolutionary theories, repeats some tired clichés and misapprehensions and does not reflect recent historical scholarship. In next discussing the present status of evolutionary theory Rostand gives a grossly oversimplified and partly mistaken statement of the "neo-Darwinist" (synthetic) position and then has no difficulty in maintaining that his version of that theory is inadequate. As supplement or corrective he offers only vague speculation and largely irrelevant philosophy. In a brief final section (about five text pages) he gives his views about man's evolutionary future, opinions already treated better and at greater length in another of his books (*Can Man Be Modified?*) where they should be read, if at all.

The awkwardness and errors stem in part from bad translation of the French original. The subject of the essay is regularly called "transformism," a Gallicism absent from proper English, and in other respects as well the translator reveals ignorance of the subject and fails to produce idiomatic literary English.

No connection whatever is made between the pictures and the text or the supposed subject of the book. The picture captions are highly inadequate. Some are incorrect: an engraving of "Armadillos and lizards" features a pangolin or scaly anteater; an "embryo" is really a larva. Others are almost humorously vague: "Unicellular form," "Fish." The few that are more precise still are not very enlightening for an average reader: "*Campylognathus Zitteli*. Fossil remains"; "*Membracid hemipteran* (true insect)." Citations of original sources are rarely given for the numerous reproductions of historic illustrations.

The binding is unattractive and that of the review copy, at least, is so poor that the book went to pieces as soon as it was opened.

It is a relief finally to be able to bestow some wholehearted praise: the pictures are magnificent. There are 41 photographs, 5 in color, and 30 reproductions of old engravings and paintings, 7 in color. Most of them are superb works of art excellently reproduced. Almost all are of animals, with great range of subject and technique: a color photomicrograph of a paramecium in cross-polarized light (that technique of course not specified); an x-ray photograph of a stingray; an 18th century colored engraving of a butterfly fish and an "*Ican Suangi*" (whatever that may be); a painting on vellum of sea turtles by Claude Aubriet (one of very few artists named); a terrific enlarged head of an Australian lizard; a color photograph of 56 jewel-like (but unidentified) beetles; a Persian miniature of a "feline" (a leopard, as it happens)—and many others. Simple contemplation of these pictures is an exciting esthetic experience. Their publication without Rostand's text, with adequate captions, and in a good binding would have been a triumph of artistic and scientific bookmaking.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Aletsch Glacier as of September 1957. Sheet 3. Topographical survey of Switzerland and section of hydrology. Federal Inst. of Technology, Zurich, Switzerland, 1960. F. 10. This series, a Swiss contribution to the IGY, is planned to present a detailed map of the Great Aletsch glacier and its drainage basin. Scale 1:10,000. This sheet covers the main glacier tongue from Marjelen Lake to the snout plus the adjoining watershed within the drainage basin. Four maps are planned.

Aspects of Public Health Nursing. Public Health Paper No. 4. Glete de Alcántara *et al.* World Health Organization, Geneva, Switzerland, 1961. 185 pp. $1.75.

Belgian Advisory Council for Scientific Policy. Annual Report, 1960. The Council, Brussels, Belgium, 1960. 132 pp. The advisory council was created on 16 September 1959. The first part of the report surveys "the future defining fundamental attitudes to problems of scientific policy in Belgium and also in the international sphere"; the second surveys the council's operations.

Clef des Cyprinidés ou Ménés du Québec. *Les Poissons d'Eau Douce*. vol. 2 of Vianney Legendre. Le Jeune Naturaliste, Joliette, Canada, 1960. 35 pp.

Financial Management in the Federal Government. Prepared by the Staff of the Committee on Government Operations, U.S. Senate. Government Printing Office, Washington, D.C., 1961. 375 pp. An analysis of existing and proposed legislation relating to the financial management of the federal government, including a history of improvements made prior to the 80th Congress, recommendations of the first and second Hoover commissions on budget and accounting and the implementation of these recommendations, legislation enacted in the area by 80th–86th Congresses, financial management improvement made by departments and agencies on a government-wide basis under specific acts, and the history of major budgeting and accounting legislation proposed.

Instrumentation and High-Speed Photography. Papers reprinted from *J. Soc. Motion Picture Television Engrs.* vol. 1, series 11. Society of Motion Picture and Television Engineers, New York, 1960. 185 pp.

Reports

Effect of Fire-Extinguishing Agents on Combustion of Sucrose

Abstract. Although sucrose and cellulose are both carbohydrates of basically similar composition, the very materials which have been found to be most effective in preventing flaming combustion of cellulose are also effective in causing sugar cubes to support flame.

A common parlor trick, on the outcome of which many a free drink has been won, involves the ignition of a cube of table sugar. As many a loser of such a bet has discovered, a normally nonflammable sugar cube can readily be ignited by a match if it is just dipped into a little cigarette ash. This phenomenon was reported in the technical literature as far back as 1919 (*1*), and the mechanism of action of the cigarette ash, as well as the nature of its responsible components, has been the subject of speculation at intervals ever since.

The treatment of combustible materials to reduce their vulnerability to fire dates back to more than 400 years B.C. (*2*). Perhaps the first systematic investigation of the fireproofing of cellulosic material was conducted by Gay-Lussac (*3*) at the request of Louis XVIII of France. Since then, many empirical investigations have been undertaken, each using large numbers of chemicals, in a search for effective fire-fighting agents (*4*) or materials which may be used to impregnate wood (*5*) or fabrics (*6*) to increase their fire resistance.

The mechanism of action of fire-extinguishing agents has frequently been related to the well-known fire triangle (heat, fuel, oxygen). Thus fire may be extinguished by cooling (for example, with water), or by isolating the fuel from oxygen (for example, by interposing a CO_2 blanket or by coating the fuel with a noncombustible, impervious layer). More recently, the effectiveness of some fire-extinguishing agents has been attributed to the breaking of the chain reactions occurring in the flame (*7*).

One other method by which chemicals may exert an effect on the combustion of solid fuels is by somehow altering the decomposition reactions (or rates of reaction) occurring in the solid. For such purposes, it is necessary to draw a distinction between flame-retardant effects and other decomposition effects, for example, glow retardance. Thus, the most highly recommended dry chemical for extinguishing fires (*8*), potassium bicarbonate, actually lowers the decomposition temperature of cellulose (*9*).

That good flame retardants may actually have a negative glow-retardant effect is illustrated in Fig. 1. For this demonstration, about 0.2 ml of 0.1*M* $KHCO_3$ solution was used to moisten a line down the side of a cellulose-extraction thimble, and the upper part of the thimble was ignited. The flames were then blown out, leaving a red glow around the entire periphery of the thimble, and the reaction was permitted to continue until no further smoke was observed. As may be seen, the glow in the untreated cellulose died out almost immediately, while the smoldering reaction continued down the entire length of the strip treated with $KHCO_3$. It appears that the roles of such salts as both flame-retarding and smoldering agents are expressions of the same reaction mechanism (*10*); this mechanism is generally accepted as a catalytic degradation of the cellulose molecule which produces large increases in the resulting char/tar ratio (*11*).

Since sucrose and cellulose are carbohydrates of basically similar composition, the catalytic action of salts which influence the oxidation of both materials should be similar. It was consequently quite surprising (to me, at least) to find that most of the reagents which have been found to have good flame-retardant properties when applied to cellulosic materials are just the reagents which cause a sugar cube to support a flame.

To test the flame-supporting effectiveness of treated sugar cubes, each cube was dipped into the particular reagent so that 1 to 2 mg of reagent adhered to the cube. An attempt was then made to ignite the treated end of the cube with a match or a bunsen burner flame (identical results are obtained with both ignition procedures). Among the materials which had little or no effect on the combustibility of the sugar were the following: charcoal, sodium chloride, calcium carbonate, calcium oxide (dry), and sodium calcium borate (dry). On the other hand, flaming ignition of the sugar cube resulted after treatment with materials such as the following: calcium oxide (slurry), calcium hydroxide (dry), sodium calcium borate (slurry), potassium bicarbonate, sodium phosphate, monoammonium phosphate, ammonium chloride, ammonium bromide, sodium silicate, sodium tetraborate, carbon tetrachloride, and methylene chlorobromide.

These results do not, of course, establish the mechanism of action of these reagents. It is felt that the negative results listed in the paragraph above show rather conclusively that the flame-supporting effect on sugar is chemical, rather than physical, in nature (thus, charcoal should be quite effective if the result were due to an increase in absorption of radiant energy). The effectiveness of the various chemical extinguish-

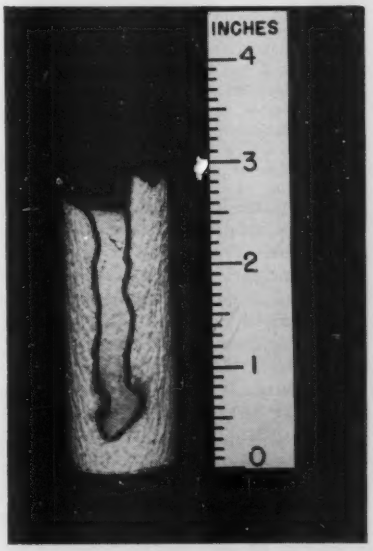

Fig. 1. Photograph of extraction thimble showing the result of glowing combustion down the line treated with potassium bicarbonate solution.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to contributors" [*Science* **125**, 16 (1957)].

ing agents in fire fighting has been repeatedly demonstrated through the years and is beyond question. However, the exact nature of the chemical effect on the degradation of the solid (cellulose or sucrose) or on the reactions in the flame can remain the source of profitable speculation for some time to come.

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References and Notes

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24 January 1961

Isotopic Variations in Meteoric Waters

Abstract. The relationship between deuterium and oxygen-18 concentrations in natural meteoric waters from many parts of the world has been determined with a mass spectrometer. The isotopic enrichments, relative to ocean water, display a linear correlation over the entire range for waters which have not undergone excessive evaporation.

Epstein and Mayeda (*1*) and Friedman (*2*) reported precise data for O^{18}/O^{16} and D/H ratios in nine nonmarine meteoric waters and found a rough linear correlation between the isotopic enrichments. In the course of research on isotopic variations in volcanic waters, I have analyzed mass spectrometrically some 400 samples of water from rivers, lakes, and precipitation in order to establish the exact nature of the isotopic relationship in meteoric waters. Gas samples were prepared by the standard CO_2-H_2O equilibration technique (*1*) and by reduction of H_2O to H_2 with uranium metal and analyzed on the McKinney-Nier type spectrometers used by the authors mentioned above as well as in my present laboratory.

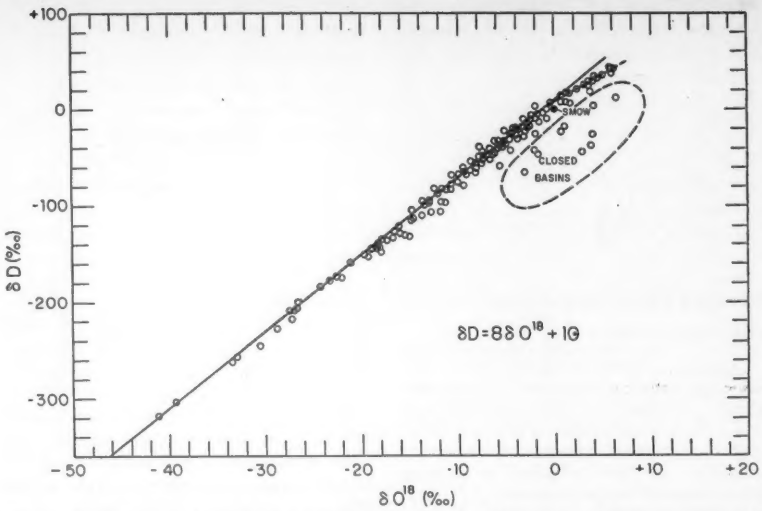

Fig. 1. Deuterium and oxygen-18 variations in rivers, lakes, rain, and snow, expressed as per millage enrichments relative to "standard mean ocean water" (SMOW). Points which fit the dashed line at upper end of the curve are rivers and lakes from East Africa.

The isotopic data for all samples analyzed for both isotopes (excluding detailed sets of data from Chicago and Steamboat Springs, Nev.) are shown in Fig. 1. About 40 percent of the samples are from North America, the rest being distributed all over the world. The data shown are per mil enrichments of the isotopic ratios D/H and O^{18}/O^{16} relative to a mean ocean water standard, that is,

$$\delta = [(R/R') - 1]\,1000$$

where R is either isotopic ratio and R' is the ratio in "standard mean ocean water" (SMOW) defined relative to the National Bureau of Standards isotopic water standard as described in a following report (*3*). The precision of the data is ±0.5 per mil, or ± 1 percent of δ, for D, and ± 0.1 per mil, or ± 0.5 percent of δ, for O^{18}, the larger error applying in each case and representing ±2 standard deviations.

The straight line in Fig. 1 represents the relationship

$$\delta D = 8\,\delta O^{18} + 10$$

(both δ values in per millage) and is seen to be an adequate fit to the data, except for waters from closed basins in which evaporation is a dominant factor governing the isotopic relationship. The samples which fit the dashed line at the high enrichment end of the curve represent rivers and lakes in East Africa. They fit a line with a slope of about 5, in contrast to the slope of 8 found for most of the data. Studies of evaporation in the laboratory, and in areas where seasonal data have been obtained, show that in free evaporation at ordinary temperatures the heavy isotope enrichment ratio $\delta D/\delta O^{18}$ consistently follows a slope of about 5 as observed in East African waters. Many of the points falling to the right of the line plotted in Fig. 1 have a similar slope of 5 when connected to points on the line which represent direct precipitation in the same area.

It can be shown (*4*) that for small enrichments the slopes in Fig. 1 are the ratios of the single-stage enrichments when the isotopic concentrations are governed by vaporization or precipitation under Rayleigh conditions at constant temperature. The isotopic vapor pressure data show that slopes of 8 and 5 correspond to Rayleigh processes at liquid-vapor equilibrium at temperatures of about −10°C and +100°C respectively. It seems, therefore, that atmospheric precipitation follows a Rayleigh process at liquid-vapor equilibrium, as first proposed by Kirshenbaum (*5*), but that the process of free evaporation at room temperature is governed by kinetic factors. The present studies have shown that this is so up to the boiling point, and that the disequilibrium occurs principally in the O^{18}/O^{16} separation (*4*). Some of the variability along the line in Fig. 1 is certainly due to evaporation effects as well as to variations in temperature of precipitation.

All points in Fig. 1 for δD and δO^{18} lighter than −160 and −22 per mil, respectively, represent snow and ice from the Arctic and Antarctic, while tropical samples show very small depletions relative to ocean water. This distribution is expected for an atmospheric Rayleigh process as vapor is removed from poleward moving tropospheric air. However, it is actually log (1 + δ)

which should be plotted for such a process, and, in such a plot, the points in Fig. 1 fall on a curve with a continually increasing slope for lighter δ values, as would be expected (from the vapor pressure data) for precipitation at lower temperatures in high latitudes. The linear relation observed in Fig. 1 simply reflects a coincidence of the effect of the increasing difference in δ and log $(1 + \delta)$ at high enrichments with the effect on the slope of the average temperature decrease for precipitation along a meridian from equator to poles (*6*).

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6. Detailed papers on isotopic variations in meteoric and volcanic waters of specific areas will be published elsewhere. It is a pleasure to acknowledge my gratitude to Harold C. Urey in whose laboratories at the Institute for Nuclear Studies, University of Chicago, most of this work was done, to Mrs. T. Mayeda for her excellent services in the Chicago laboratory, and to G. Boato for many interesting discussions. This research has been supported by the National Science Foundation, the University of California Water Resources Commission, the Office of Naval Research, and the Atomic Energy Commission.

18 January 1961

Germination of Bacterial Endospores with Calcium and Dipicolinic Acid

Abstract. Aerobic and anaerobic bacterial endospores can be germinated if calcium chloride and dipicolinic acid are added to well-washed suspensions. Maximum germination is obtained when the calcium and acid are present in a molar ratio of one or more. This suggests that the 1:1 chelate of calcium and dipicolinic acid is the agent that induces germination.

During experiments concerned with the effect of chelating agents on spore germination, we observed that germination was induced when calcium chloride and dipicolinic acid (2,6-pyridine dicarboxylic acid) were added to suspensions of clean, well-washed bacterial spores provided that the molar ratio of calcium to dipicolinic acid was 1:1 or higher.

The procedure was to dissolve the dipicolinic acid in enough NaOH solution to give a neutral solution of known strength. A standard $CaCl_2$ solution, either with or without tris buffer, was mixed with the solution of dipicolinic acid and NaOH immediately before addition to the spore suspension. In such mixtures of calcium and dipicolinic acid, we have been able to germinate spores of the following organisms: Putrefactive anaerobe 3679 (NCA and h strains), putrefactive anaerobe S_2, *Clostridium perfringens, Bacillus cereus, B. megaterium, B. mycoides, B. subtilis,* and *B. coagulans.* The germination was sometimes incomplete, but in most cases rapid and complete germination took place.

The effect of calcium and dipicolinic acid on germination seemed to be rather specific. None of the following metal ions could be substituted for calcium: Na^+, K^+, Mg^{2+}, Mn^{2+}, Ba^{2+}, Co^{2+}, Zn^{2+}, Cu^{2+}, Ni^{2+}, Fe^{3+}. Neither could other chelating agents or any of the other pyridine dicarboxylic acids be substituted for dipicolinic acid.

Table 1 shows that germination with calcium and dipicolinic acid, as measured either by counting residual (heat-resistant) spores or by counting the dark and the refractile spores with a phase-contrast microscope, is quite rapid.

The effect of different ratios of calcium and dipicolinic acid was tested by adding various concentrations of the acid to a germination solution containing 40 mmole of $CaCl_2$. Figure 1 shows the results obtained with *Bacillus megaterium* and putrefactive anaerobe S_2.

Chelation takes place when dipicolinic acid is added to a solution containing calcium ions. The calculated concentrations of the 1:1 chelate of calcium and dipicolinic acid are also plotted on the graph. The relationship between the two curves provides a strong suggestion that this chelate is the active inducer of germination. The calculation of the concentration of the 1:1 chelate of calcium and dipicolinic acid was based on data obtained by titrations of the acid with NaOH in the presence and absence of calcium ions. These titrations showed that two types of chelates with different stability constants were formed. If the molar concentration of calcium equals or exceeds that of dipicolinic acid, a chelate is formed between 1 mole of calcium ion and 1 mole of the acid. If the concentration of dipicolinic acid is increased over that of calcium, the formation of a higher chelate containing 2 moles of the acid per mole of calcium ion takes place. That this 1:2 chelate apparently has little or no germination-stimulating effect is also indicated in Fig. 1. This has been further substantiated by similar experiments with other organisms showing that germination in the presence of optimum calcium (40 mmole) is decreased by excess dipicolinic acid. The addition of excess calcium to a given solution of the acid does not change the concentration of the 1:1 chelate, and such additions have been shown to have little or no influence on the germination rate.

Table 1. Germination of *Bacillus megaterium* and putrefactive anaerobe S_2 spores in 40 mmole of $CaCl_2$, 40 mmole of dipicolinic acid, and 10 mmole of tris buffer at *p*H 7.0.

Incubation (min)	Germination (%) based on	
	Phase microscopy	Pasteurized counts
	*B. megaterium**	
0	0	0
5	0	
10	81	100
20	99	100
	Putrefactive anaerobes S_2†	
0	0	0
5	93	98
10	99	100

* Incubation temperature, 25°C. † Incubation temperature, 35°C.

Germination with the 1:1 chelate of calcium and dipicolinic acid took place readily over a *p*H range of 5 to 9, but was generally most rapid at values close to *p*H 7. The concentration of calcium and dipicolinic acid required for rapid germination was between 20 and 40 mmole, which is somewhat higher for the aerobes we have tested than for the anaerobes. The optimum temperature for germination with the 1:1 chelate of calcium and dipicolinic acid was about 45°C for clostridial spores, but most aerobic spores were found to germinate very slowly or not at all at temperatures above 35°C. This was apparently because of the formation of a precipitate of calcium and dipicolinic acid when the concentration of calcium and the acid was higher than about 20 mmole. The rate of precipitation was increased at higher temperatures and

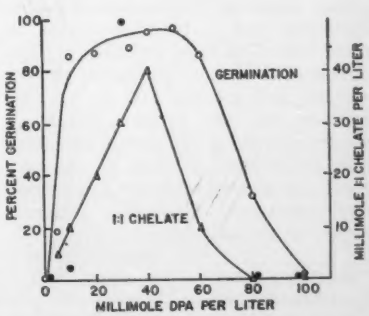

Fig. 1. Germination of spores suspended in 10 mmole of tris buffer, 40 mmole of $CaCl_2$, and varying concentrations of dipicolinic acid (DPA). Open circles: spores of putrefactive anaerobe S_2 incubated at 35°C for 60 minutes. Closed circles: spores of *Bacillus megaterium* incubated at 25°C for 30 minutes. Triangles: the calculated concentration of the 1:1 chelate of calcium and dipicolinic acid.

thus may have prevented germination of aerobic spores which required a concentration of the 1:1 chelate of close to 40 mmole. If the precipitation was retarded by the addition of amino acids or protein (gelatin)—substances which by themselves did not induce germination—to a solution of calcium and dipicolinic acid, germination of *Bacillus* spores also took place at higher temperature.

The literature contains very little information concerning the effect of chelating agents on spore germination. Powell (*1*) reported that the germination of *Bacillus subtilis* spores with L-alanine was inhibited completely by 10 mmole of oxine or 2,3-dimercaptopropanol (BAL). Brown (*2*) observed that the putrefactive anaerobe PA 3679 could be made to germinate in solutions of ethylenediaminetetraacetic acid; however, an optimum amount had to be used. If too much was added, the spores did not germinate. We have been able to reproduce Brown's observations by using putrefactive anaerobe 3679, but none of the other spore formers we tested germinated with ethylenediaminetetraacetic acid. We have also observed that some of the spore suspensions of PA 3679 could be germinated with tripolyphosphate or dipicolinic acid alone. Here, as with ethylenediaminetetraacetic acid, an optimum concentration had to be used. The inhibitory effect of high concentrations could be reversed by the addition of calcium chloride.

It is not yet possible to explain the mechanism by which a mixture of calcium and dipicolinic acid induces germination. Neither is it known whether the calcium and dipicolinic acid naturally present in spores have a stimulatory function when germination is induced by other agents, that is, added amino acids or mechanical abrasion. However, such a function cannot be ruled out. The large amounts of dipicolinic acid (6 to 12 percent of the dry weight) and calcium (1.5 to 3.0 percent of the dry weight) present in spores provide a calcium-to-dipicolinic acid molar ratio of close to one; this could conceivably affect the germination rate, particularly after these materials appear in the suspending medium.

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13 January 1961

Applications of Fluorescent Brighteners in Biological Techniques

Abstract. The visual labeling of various microorganisms has been accomplished with specific fluorescent ultraviolet-absorbing compounds that not only have been bound by the cell but have been transferred by it to subsequent growth. The possibility of application to genetic studies is suggested.

Although the use of fluorescent substances to visualize specimens was initiated in 1914 by Provazek (*1*), this technique has developed slowly. It was not until the early 1930's that the fluorescent dyes acriflavine, fluorescein, primulin, rhodamine, and thioflavin were applied to living tissues (*2*), and it was not until 1940 that the diamino acridines were used as vital stains (*3*). The interaction of the diamino acridines with nucleoproteins has formed the basis of techniques for observations of virus-infected cells (*4*), of the multiplication of bacteriophage in lysogenic cells (*5*), and of the multiplication of bacteria and yeast cells (*6*). In all of these experiments the dye has been used either as a simple stain with or without fixation or has been kept constantly in contact with the cells.

The possible use of fluorescent substances not only as vital stains but also as markers for genetic and developmental studies of microorganisms is reported here. Such compounds should be essentially nontoxic at the concentration employed, efficiently absorbed by the cell, and sufficiently stable for detection in subsequent growth. Attempts to use such well-known vital fluors as acridine orange, fluorescein, rhodamine, and thioflavin were unsuccessful in preliminary trials. Some of the commercially available official bleaching agents or brighteners, however, were found to offer some possibility of successful application. These substances appear to be (i) highly fluorescent, (ii) able to pass through cell walls, (iii) substantive to proteins, (iv) fluorescent at *p*H 5.0 to 8.5, and (v) stable as regards fluorescence when bound.

Among the brighteners tested, those of the diamostilbene class with substantivity for cellulosic fibers were selected for preliminary investigations. These compounds were added to submerged shaker fermentations, either before inoculation or after a period of incubation. Both synthetic and natural media were employed. Although the uptake of these brighteners by the cell wall was essentially instantaneous, distribution within the cell required a longer period of time. It is of significant interest that active growth centers have evidenced the greatest concentration of these fluors, as for example the budding region in yeast cells, hyphal tips, and germ tubes. When fluorescent cells which were washed three times with sterile 0.85 percent NaCl were transferred to liquid or agar medium, subsequent growth fluoresced. Fluorescent spores which were washed three times with sterile 0.85 percent NaCl also gave rise to fluorescent mycelium. Indications are that leaching of the fluorescent compounds into the medium did not occur to an extent sufficient to cause this fluorescence, since other organisms which had previously been observed to fluoresce with these particular substances did not do so when introduced into the medium. There is obviously a point at which this fluorescence may become undetectable by reason of consecutive dilution as growth proceeds.

Observations were made in a dark room with a magnesium fluoride coated microscope with an 85-watt mercury arc lamp and a No. 5840 Corning exciter filter; a set of Wratten barrier filters was fitted in the oculars, and an aluminized mirror was placed over the substage mirror of the microscope. Cargille's immersion oil Type A of very low fluorescence was used. In addition to the usual microscopic observations, hanging drop and agar cover-slip preparations were also employed for growth and reproduction studies.

A specific example of this technique follows. *Penicillium chrysogenum* (Wisconsin Q176) was grown at 28°C on a reciprocal shaker for 1 day in a 250-ml erlenmeyer flask containing 50 ml of a corn steep liquor-glucose medium. At this time 0.01 ml of a 12 percent solution in aqueous Cellosolve of the disodium salt of 4,4′-bis [4-anilino-6-bis(2-hydroxyethyl) amino-S-triazin-2-ylamino]-2,2′-stilbenedisulfonic acid (*7*) was added. On the second day a blue fluorescent differentiation was evident within the cells as well as in the side walls and cross walls of the mycelium; there was marked concentration of fluorescence at the hyphal tips which glowed brightly. That this fluorescence is stable is shown by the observation that refrigerated mycelium has continued to fluoresce strongly for the past 6 months. The fluorescent mycelium was washed three times with sterile 0.85 percent NaCl and was then transferred at a concentration of 1 percent to fermentation shaker flasks containing corn steep liquor-glucose medium. Hanging drop slides were also prepared. Transfers were incubated at 28°C. New growth in both instances showed a blue fluorescence.

The technique of fluorescent labeling with brighteners has been applied to bacteria (*Bacillus subtilis* ATCC 6633

and *Escherichia coli* QM B1457), yeasts (*Saccharomyces cerevisiae* ATCC 7753), actinomycetes (*Streptomyces aureofaciens* ATCC 10762), and higher fungi including *Mucor murorum* QM 776, *Penicillium chrysogenum* Wisc. Q176, and *Neurospora crassa* ATCC 9683. Additional experiments are in progress. It is hoped that this technique may be used to study hyphal fusion, cytoplasmic inheritance, and genetic recombination as well as the more common developmental processes. Other applications may be expected to become apparent as the technique is explored further.

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8 February 1961

A Quantifiable Behavioral Correlate of Psychotogen and Tranquilizer Actions

Abstract. A representative psychotogen, lysergic acid diethylamide (LSD-25), in doses small enough to be devoid of gross effects, increases response latency in rats to a tone indicating the availability of water reward; this effect is greatly reduced by prophylactic administration of a representative phenothiazine tranquilizer, chlorpromazine (CPZ), in doses that per se do not affect performance. The nature of the chlorpromazine action and its competition with lysergic acid diethylamide is revealed by the effects of chlorpromazine in larger doses.

It was felt that the significance of the cerebral synaptic inhibitory action of psychotogens and the competition by tranquilizers established in these laboratories (*1*) could be understood further and a beginning made in assessing their role in behavior, if quantitative behavioral correlates could be found. One correlate that has proved valuable has been the lever-pressing of thirsty rats for a water reward, when a tone indicates its availability. This conditioned approach behavior, monitored by measuring the stimulus-response latency (length of upper vertical line, with corresponding reward achievement indicated by the marks on the lower line of each strip in Figs. 1 and 2), shows clear inhibition after intraperitoneal injection of a moderate dose of lysergic acid diethylamide (strip 3). As seen in an example (Fig. 1), the latency exceeds the 20-second period within which reward is possible and recycling of the trial takes place after a randomly timed interval. In the doses used, the inhibitory action is selective and not due to general sedation. A preventive intraperitoneal injection of chlorpromazine, in a dose that per se produces no change in the same animal (strip 2), readily gives protection as shown by the abbreviated effect of subsequent lysergic acid diethylamide (strip 4) (*2*).

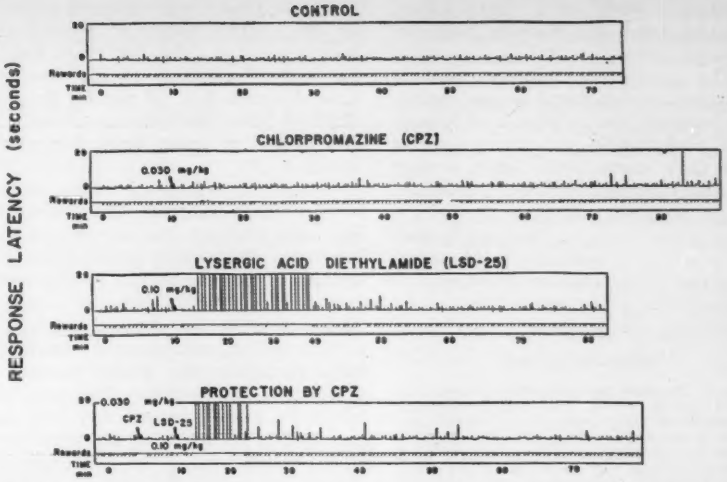

Fig. 1. Lysergic acid diethylamide (LSD-25) inhibition and chlorpromazine (CPZ) protection on approach behavior in rat.

The nature of the antagonism of lysergic acid diethylamide and chlorpromazine to each other is revealed by the effects of larger doses (Fig. 2). Thus, the larger, but nondepressant dose of chlorpromazine enhances instead of reducing lysergic acid diethylamide inhibition, while a still larger dose produces a depression of approach behavior that resembles the effect of lysergic acid diethylamide, but is distinguished from it by a considerable degree of sedation. The observed antagonism and summation are the characteristics that mark the competition between two substances with like actions but very different potencies. Because of this the weaker agent can, when it has gained access to the site of action (receptor) in moderate quan-

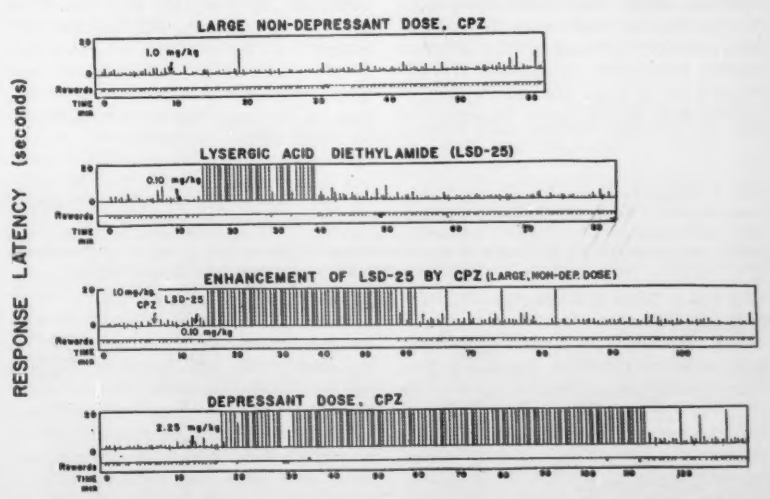

Fig. 2. Effects of larger than protective doses of chlorpromazine (CPZ) on approach behavior in rat.

tities, pre-empt a portion and, by substituting a weak for a strong action, subtract from and compete with the stronger action.

The parallelism between cerebral synaptic and behavioral actions, including reported clinical effects, of lysergic acid diethylamide and chlorpromazine and their competition lends support to the interpretation and confidence in the methods utilized.

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2. The effects of the injection procedure per se and of possible local actions at the site of injection were excluded by negative results with saline injection and with injections of LSD-25 during periods of high tolerance to this drug. The latter helps eliminate the possibility that a local irritant effect of LSD-25 might have been thought to be offset by an alleged local anesthetic action of chlorpromazine.

21 November 1960

Action of d-Tubocurarine Chloride on Net Flux of Water across Isolated Frog Skin

Abstract. *d*-Tubocurarine chloride, when added to the solution bathing the outside of the isolated frog skin, enhances the net flux of water which arises from the influence of an osmotic gradient. Although this effect appears to result from alteration in the pore size of the membrane, it is not accompanied by any consistent change in the resting potential.

Some years ago, Kirschner (*1*) showed that the addition of *d*-tubocurarine chloride (curare) to the solution bathing the outside of the skin of various species of frogs produces a reversible increase in the active transport of sodium. These results have been confirmed by others who observed a similar effect with a variety of neurotropic compounds (*2*). On the other hand, the lack of response of the skin of *Rana temporaria* L. to curare, already noted by Kirschner, was also confirmed and shown to result from hormonal variation (*3*).

In order to explain the enhancement of the active transport of sodium, it has been proposed that curare acts by increasing the passive permeability to sodium of the membrane of the skin epithelial cells which face the outside. This results in an increase in intracellular sodium concentration, which in turn stimulates the active transport mechanism for sodium. One way in which the passive permeability may be increased is by changing the pore size of the membrane. If this hypothesis is correct, one should also expect a modification of the net flux of water arising across the frog skin under the influence of an osmotic gradient. The purpose of the present study has been to test this hypothesis by measuring the net flux of water across the skin and to determine the effect of curare on such flux.

The apparatus used is similar in principle to the one described by Koefoed-Johnsen *et al.* (*4*). The experiments were performed on the isolated skin of *Rana temporaria temporaria* L. bathed with ordinary Ringer's solution on the inside and with Ringer's at a 10-fold dilution on the outside. After a control period of about 4 hours, curare was added to the outside solution at a concentration of 170 μg/ml. Table 1 shows the results obtained on the net flux of water as well as on the difference in electrical potential across the skin.

It can be seen that curare at the concentration used consistently enhanced the net flux of water. In some instances the flux rate was five times that of the control, although in most experiments the rate was enhanced two- to threefold. These results are consistent with the hypothesis that curare acts on the frog skin by increasing the diameter of membrane pores. However, it is important to note that, despite the apparent increase in membrane permeability to water, the membrane potential was not consistently altered.

The following conclusions may be drawn from these results. Although some of the results are contradictory to the proposed mechanism, it may be suggested that in these cases, for still obscure reasons, an intracellular increase of sodium concentration due to an increase in passive diffusion may not always enhance active transport. On the other hand, the hypothesis first proposed to explain the effect of curare on the active transport of sodium may not be correct, in that an increase in net flux of water and an increase in passive sodium permeability may result from two different mechanisms. Finally, the enhancement of active transport by curare cannot be explained in terms of an increase in the passive permeability to sodium (*5*).

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Table 1. Effect of curare on the potential difference and net flux of water across the isolated skin of *Rana temporaria temporaria* L. (Ringer's solution inside, Ringer at 1:10 outside). The time in hours indicates the duration of the control or experimental periods. Δ Potential difference is the maximum variation of the potential difference observed after application of 170 μg/ml of *d*-tubocurarine chloride in the outside solution. The minus sign indicates an increase in potential difference.

Experiment No.	Control		Curare		
	Time (hr)	Net flux of water (μl cm^{-2} h^{-1})	Time (hr)	Net flux of water (μl cm^{-2} h^{-1})	ΔPotential difference (mv)
1	4	5	4	8	–
2	4	3	3.5	7	4
3	4	3	4	4	11
4	4	3	3	16	6.5
5	4	3	3.5	15	7
6	3.5	3	3.5	9	4
7	3	5	1.5	12	−9.5
8	3	4	2.5	11	−1.5

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Excretion of Dopamine in Diseases of Basal Ganglia

Abstract. The urinary excretion of catecholamines has been measured in 32 patients with disorders of the basal ganglia. Sixteen patients with Parkinsonism (idiopathic, postencephalitic, and arteriosclerotic types) had a significantly lower amount of dopamine in the urine during a 24-hour period than a group of 24 normal control subjects. In a group of 16 patients with various striatal syndromes the excretion of dopamine and epinephrine was significantly higher than normal. Norepinephrine excretion was similar in the three groups. The lowest mean value of urinary dopamine was found in postencephalitic Parkinsonism; the highest occurred in Wilson's disease.

Recent chemical studies have revealed that 80 percent of the dopamine (3-hydroxytyramine) content of the brain is located within the corpus striatum (*1*). The differential concentration of norepinephrine and dopamine in

Table 1. Excretion of urinary catecholamines (μg/24 hr).

Group	Cases (No.)	Samples (No.)	Mean ± standard error		
			Dopamine	Norepinephrine	Epinephrine
Normal	24	24	316 ± 14.6	42 ± 3.2	17 ± 1.1
Parkinsonism (all types)	16	16	241 ± 21.5*	40 ± 5.0	15 ± 0.4
Postencephalitic	6	6	177 ± 41.8*		
Idiopathic	8	8	297 ± 36.2		
Arteriosclerotic	2	2	212		
Striatal syndromes (all types)	16	32	377 ± 23.9*	36 ± 3.3	28 ± 3.7*
Wilson's disease	3	17	418 ± 24.8*		
Huntington's chorea	4	5	272 ± 45.8		
Dystonia	4	5	395 ± 45.8		
Sydenham's chorea	2	2	334		
Familial tremor	1	1	334		
Torticollis	1	1	328		
Choreoathetosis	1	1	308		

* Probability of difference from normal, $p < 0.01$.

various portions of the brain led Carlsson (*2*) to postulate a second role for the latter substance besides its established function as precursor of norepinephrine and epinephrine. This role has been related to the functioning of the extrapyramidal system (*3*). One of us (*4*) has reported the presence of a smooth muscle-stimulating substance, later identified as dopamine (*5*), in the urine of patients with diseases of the basal ganglia. The present report (*6*) concerns the differential urinary excretion of dopamine in Parkinsonian and some striatal syndromes.

Thirty-two patients and 24 normal control subjects (laboratory personnel) contributed 24-hour samples of urine for the determination of dopamine, norepinephrine, and epinephrine excretion. Epinephrine and norepinephrine were measured by the trihydroxyindole method (*7*, *8*), and dopamine by a modification of the Carlsson-Waldeck procedure (*8*). Fluorescence measurements were carried out with the Aminco-Bowman spectrophotofluorometer.

Urines were collected for periods of 24 hours in bottles containing 10 ml of 18 percent hydrochloric acid as a preservative. All medication was withheld for 24 hours before the collection period and during it. A total of 72 urines were analyzed.

The 32 patients represented the following diagnoses: postencephalitic, idiopathic, and arteriosclerotic Parkinsonism, Wilson's disease, Huntington's and Sydenham's choreas, dystonia musculorum deformans, torticollis, familial tremor, and choreoathetosis. The division into "Parkinsonian" and "striatal" syndromes was based mainly upon the known pathology of the particular diseases concerned.

The summary of the data for the three catecholamines in Table 1 shows that the daily excretion of dopamine in the two main diagnostic divisions departs significantly from normal. The means, arranged according to rank, are Parkinsonism < normal < striatal syndromes, and the ratio of the means is 0.76:1.00:1.20. Because of the large variation encountered in these series of cases, it was of interest to determine the extent to which this over-all distinction, based upon the urinary output of dopamine, carries over to the diagnostic entities mentioned. For this purpose the data were subjected to the analysis of variance (*9*), and the residual error, after accounting for variance between specific diagnostic categories, was used to calculate the standard errors shown. Inspection of Table 1 reveals that in postencephalitic Parkinsonism the dopamine excretion is significantly lower than normal, and that in Wilson's disease this excretion is higher than normal. Some of the categories contained too few cases to permit statistical evaluation.

Epinephrine excretion was also significantly greater than normal in the striatal syndromes considered as a whole (Table 1), but the variability within the diagnostic categories was so great that further analysis of the data did not seem warranted. Norepinephrine excretion did not vary significantly between the major groups.

The physiological significance of these findings is difficult to assess because of lack of knowledge about the actual function of dopamine and its metabolites in the brain. However, the results support the hypothesis that dopamine plays a role in extrapyramidal motor function. The association of gross differences in the urinary output of dopamine with certain neurological diseases indicates the importance of further studies of the metabolism of this catecholamine in these disorders. Such investigations should include analysis of the catecholamine content of the brains of patients who have died with basal ganglia disease, for such information can help determine whether the concentration of cerebral dopamine itself undergoes major changes in these disorders (*10*).

Note added in proof: Ehringer and Hornykiewicz (*11*) have shown that the concentration of dopamine in the neostriatum is significantly reduced in cases of Parkinsonism. The norepinephrine level in the hypothalmus is also low.

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28 November 1960

Possible Physical Effect of Solar Particles on Meteorological Parameters in Alaska

Abstract. Statistical significance was found in the reception of solar-particle invasions to sea-level pressure and upper-flow pattern changes at 500 mb in Alaska during a period of high solar activity. Recent IGY findings suggest that a physical relation exists between such solar particles and atmospheric changes.

For a sample of ten weather stations in Alaska and northwestern Canada, enclosed within an area between 60° and 70°N and 170° and 120°W, the sea-level pressure was tabulated for 16 days after a day (the key day) in which the earth's magnetic field was particularly disturbed. A key day is defined as a day in which the daily magnitude of the A_p index was 20 or more with a daily change of +10 or more from the previous day. The values of this index for the fall through winter of 1956–57 were taken from the *Journal of Geophysical Research* (*1*). For each of the ten sample stations the 24-hr pressure change was obtained

Table 1. Ridge frequencies at 500 mb for fall through winter of 1956–57.

Days after key days	170° to 150°W	140° to 120°W
1 and 2	14	25
3 and 4	14	21
5 and 6	19	22
7 and 8	8	37
9 and 10	7	28
11 and 12	6	20
13 and 14	9	26
15 and 16	11	21

with the pressure of the preceding day subtracted from the pressure of the following day. For each of the key days the mean 24-hr pressure change was individually calculated for each day of the 16-day period for the ten stations. A table was compiled showing the day-to-day pressure changes. A Student's t test was applied to the data, and significance was found at less than the 5 percent level in the mean 24-hr fall in sea-level pressure for the period from the 7th to the 8th day after key days.

A study was next made of the effect of particle invasions on the mean zonal and meridional flows in the Alaskan area at 500 mb for the same period of time. No statistical significance at less than 5 percent was found for any day after the key days in the day-to-day mean zonal flow changes. To determine the meridional flow between 60° and 70°N, a grid of points on the 500-mb chart was chosen for every 10° of longitude between 120° and 170°W along three parallels of 60°, 65°, and 70°N. The contour heights were tabulated to the nearest 50 ft. The absolute value of the meridional flow between each 10° longitude interval was calculated for the three latitude lines. The expression for the meridional flow was taken from Petterssen (*2*). A table was compiled showing the data for the day-to-day differences of the mean meridional flow after the key days. A Student's t test showed significance at less than the 5 percent level in the decreases in the mean meridional component for the 7th to 8th day period after key days.

A tabulation was made of the daily A_p changes, the mean 24-hr sea-level pressure changes, and the 24-hr changes of the mean meridional flow at 500 mb for the 7th to 8th day period after the daily A_p changes between 3 Sept. 1956 and 18 Mar. 1957. To obtain a degree of relation among the variables, the method of partial-correlation studies was used. A correlation coefficient of −0.021 was found between the mean 24-hr sea-level pressure changes and the 24-hr changes of the mean meridional flow at 500 mb. Both the correlation coefficients of −0.220 between the mean 24-hr pressure changes and the daily A_p changes, and −0.146 between the 24-hr changes of the meridional flow and the daily A_p changes, were found to be significant at less than 5 percent. Each test of significance involved 200 pairs of observations.

A frequency table for the presence of ridges at 500 mb was prepared as shown in Table 1. A ridge was defined to be positioned along the longitude having an average contour height higher than any longitude immediately preceding or following. Table 1 shows a tendency for maximum ridge occurrence for the 7th to 8th day period in the area east of Alaska between 140° and 120°W. An application of the Student's t test was used to determine any significance for ridge occurrence in the area for this time. The test involved the comparison of the means of two independent samples. The null hypothesis made was that the two samples came from the same population, and the observed difference of the means of the samples was tested for significance. As the area between 140° to 120°W contains a total of eight observations, then the level of significance corresponding to the t value of 4.29 was multiplied by eight. As this gives a level of significance less than 5 percent, then a significant tendency for maximum ridge frequency in the 7th to 8th day period after key days to the east of Alaska is found.

The above findings suggest that particle invasions from active regions on the sun physically affect the earth's atmosphere with its attendant sea-level effects. Recent findings (*3*) indicate that, whenever Sputnik III was north of 60°N geographic latitude in the auroral zone, a sharp increase in the measured intensity of x-ray radiation was observed. Presumably this is due to the effect of electrons impinging upon the upper atmosphere. Recent IGY satellite findings indicate that charges penetrating to low levels in the polar regions are associated with x-ray production. Such findings point out that large energy flux, such as that coming from solar flares, is sufficient to heat the upper atmosphere. The stratospheric warming over southeastern Europe in January 1958, a few days after a considerable increase in the drag of Sputnik II was observed, is attributed by Scherhag (*4*) to the influence of solar disturbances in the atmosphere. The solar storm of 12 November 1960 had been found to increase the air density of the upper atmosphere (*5*). Atmospheric heating by solar particles given off by this solar storm is thought to be responsible for the increase of drag on Echo I. It is suggested that the particle heating caused an expansion of the lower atmosphere with an increased air density at higher altitudes.

The heating effect should be present in the segment of the auroral zone in which the present study was made. The indicated statistical significance in ridge occurrences to the east of Alaska during high solar activity seems to bear out the effects of atmospheric heating by solar-particle invasions. The fact that the falls in sea-level pressure in Alaska accompany the ridge occurrence to the east of Alaska suggests that a physical relation does exist between solar-particle invasions and atmospheric changes.

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9 March 1961

Substance in Peripheral Nerve Which Influences Oxygen Uptake

Abstract. Rat sciatic nerve contains a substance that diffuses into the surrounding medium and causes a fresh normal nerve to respire at an increased rate. Both the utilization of glucose and the increase in oxygen uptake with electrical stimulation of nerves in the presence or absence of glucose appear to be dependent on the presence of this substance.

The purpose of the experiments reported here was to elucidate some of the mechanisms concerned with the respiratory activity of isolated peripheral nerves, with and without electrical stimulation, in the presence and absence of added substrate.

Sciatic nerves, averaging 5 cm in length and 30 mg in weight, were obtained from adult Wistar rats weighing 225 ± 20 g. Respiration was measured at 37°C by the standard manometric procedure. Each nerve was placed in a Warburg flask containing 2 ml of a calcium-free, phosphate-buffered medium (initial *p*H 7.8 to 8.0) containing, in millimoles: NaCl, 122; KCl, 3; $MgSO_4$, 1.2; and phosphate buffer, 17.5. In some experiments glucose was added in 0.5 ml of additional medium to reach a final concentration of 0.01*M*. The vessels were gassed with pure oxygen. Respiratory activity was measured over 120 minutes.

Oxygen uptake was also measured in a medium in which a fresh nerve had been incubated previously. This incubation was at room temperature in 2.5 ml of the usual medium for times varying from 30 to 120 minutes. The nerve was removed and 2 ml of the

medium were taken for subsequent experiments. This medium is hereafter referred to as the "activating" medium, and the nerve which was incubated and then removed is called a "deactivated" nerve.

Warburg flasks were modified so that electrical pulses could be applied to nerves during the measurement of oxygen uptake. A Grass S4-E stimulator delivered 0.1-msec, 6-volt square-wave pulses to the nerve through a stimulus isolation unit at a frequency of 200 pulses per second. The pulses were delivered through two insulated silver-wire electrodes passed through the side arm into the main chamber of the flask. The nerve was suspended by its midportion on the exposed ends of the electrodes, which were 1 to 3 mm apart, and the electrodes and nerve were lowered into the medium.

Table 1 shows that when a normal nerve was placed in an "activating" medium there was an increase in the rate of oxygen uptake from 75 μl to 143 μl per 100 mg (wet wt.) in 2 hours. When a "deactivated" nerve, previously incubated in normal medium for 2 hours, was transferred into fresh normal medium, the average oxygen uptake was 70 μl per 100 mg (wet wt.) per 2 hours, about the same as that obtained with a normal nerve. However, when a "deactivated" nerve was placed in an "activating" medium, no significant increase in oxygen uptake occurred. Thus an "activating" medium increases the resting oxygen uptake of only a normal fresh nerve.

Table 1 also shows the increased oxygen uptake of a nerve in the presence of glucose, 119 μl per 100 mg (wet wt.) per 2 hours, compared to 75 μl obtained without glucose. When a "deactivated" nerve was placed in a medium containing glucose, no such increase was obtained. Similarly, no increase in oxygen uptake occurred when a "deactivated" nerve respired in an "activating" medium containing glucose. These results suggest that the effect of added glucose is dependent on the presence of the "activating" substance in the nerve itself. It was also found that glucose must be present in the medium at the start of the experiment in order to increase the oxygen uptake of a normal nerve.

Table 1 also shows the oxygen uptake during electrical stimulation of a "deactivated" nerve placed in normal and "activating" media. The nerve was "deactivated" by previous incubation in normal medium for 1 hour. The medium was then removed with a pipette, the nerve was washed once with normal medium, and 2 ml of normal medium were placed in the flask. Electrical pulses applied for 2 hours to nerves treated in this way gave mean oxygen uptakes of 82 μl per 100 mg (wet wt.) per 2 hours, compared to 127 μl obtained by stimulating a fresh nerve in a normal medium. Thus no significant increase in oxygen uptake occurred during electrical stimulation of a "deactivated" nerve in a normal medium.

However, other nerves, "deactivated" by previous incubation for 1 hour in the regular medium, "washed" with this used medium, and electrically stimulated in this medium (that is, the "activating" medium), showed a marked increase in oxygen uptake, averaging 129 μl per 100 mg (wet wt.) per 2 hours. These results are similar to those obtained during electrical stimulation of a fresh nerve in a normal medium. Thus the increased respiratory rate shown by nerve during electrical stimulation appears to be dependent on the presence of an "activating" substance either in the nerve or in the medium.

Finally, electrical stimulation of a fresh nerve in the presence of glucose in fresh medium gives an average oxygen uptake of 161 μl per 100 mg (wet wt.) per 2 hours. This rate is higher than that obtained from electrical stimulation (without glucose) or from a glucose medium without electrical stimulation. In contrast, the respiratory rate of a "deactivated" nerve is not increased under similar conditions.

Experiments were made to determine whether a release of sodium or potassium from the nerve was responsible for the results obtained. Analysis of "activating" media prepared by incubation of fresh nerves with and without electrical stimulation revealed only slight increases of sodium and potassium content. The addition of these amounts of ions to normal media resulted in approximately a 20-percent increase of oxygen uptake. A 70- to 80-percent increase was obtained with "activating" media. No glucose was found in the "activating" media either before or after electrical stimulation.

We conclude that during the incubation of a nerve in a glucose-free (*1*) medium a substance is released into the medium which is capable of stimulating the respiration of a second fresh nerve when it is placed in the medium. No stimulation of respiration occurred when the second nerve had already been depleted of this substance by prior incubation. The addition of glucose to the medium causes an increase in the oxygen uptake of nerve provided that the "activating" substance is present in the nerve itself. Electrical stimulation increases the oxygen uptake of nerves only if the "activating" substance is present, either inside the nerve or in the medium. Electrical stimulation of normal nerve in the presence of glucose causes an oxygen uptake rate greater than that achieved from either stimulus or glucose alone. No such increase is obtained in the absence of the "activating" substance. Since "deactivated" nerve does not respond to electrical stimulation in normal medium but does in an "activating" medium, it seems possible that electrical stimulation in some way permits re-entry of the "activating" substance into the nerve from the medium (*2*).

Table 1. Oxygen consumption of normal and "deactivated" rat sciatic nerves in various media. [Oxygen uptake is given in microliters per 100 mg (wet wt.) over 2 hours ± standard deviation. The numbers of experiments performed are shown in parentheses.]

Nerve condition	Medium		
	Normal	"Activating"	Glucose
Normal	75 ± 7 (130)	143 ± 26 (25)*	119 ± 8 (25)*
"Deactivated"	71 ± 16 (4)	87 ± 6 (6)	82 ± 8 (19)
Normal and electrical stimulation	127 ± 5 (68)	126 ± 2 (4)	161 ± 10 (24)*
"Deactivated" and electrical stimulation	82 ± 6 (10)	129 ± 5 (10)*	84 ± 5 (6)

* These results compared to relevant normal medium; all gave P values <0.01.

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Notes

1. Deactivation has also been found to occur on incubation in a medium containing glucose.
2. Further studies on the nature of the "activating" substance are in progress. This work was supported by a grant from the Multiple Sclerosis Society of Canada. Montreal Neurological Institute Reprint No. 681.

11 January 1961

Association Affairs

Preliminary Announcement of the Denver Meeting and Call for Papers by AAAS Sections

As stated in a recent issue [*Science* **133**, 1429 (5 May 1961)], the Association's 128th meeting, 26–31 December, will be the first winter meeting ever held in Denver. It will be an event long looked forward to and at last made possible by the availability of new hotel facilities. This will be the third Denver meeting, but the first and second meetings in the Rocky Mountain metropolis were held as long ago as August 1901 and June 1937.

Those who have attended recent AAAS meetings—notably in Chicago in 1959 and last December in New York—need not be reminded that no other scientific meeting presents such a variety of important and attractive symposia in all major fields of science or affords such opportunities for interdisciplinary programs and special events of general interest. Those who have not been to an AAAS meeting for some years may not realize what steady growth there has been in the variety of the sessions and in the attendance—a reflection of the ever-increasing attractiveness of the programs.

Proceedings of some of the many symposia, or their constituent papers, are eventually published—as AAAS symposium volumes, as lead articles in *Science*, or in specialized journals—but not all are, and, in any event, there is a time lapse. Moreover, only those persons who are present can meet the authors face to face and discuss points of interest with them. Many of the symposia will be of particular assistance to college teachers.

This Denver meeting is expected to be the largest general scientific gathering ever held in the region; the physical facilities, however, are adequate and attractive. The quality of the programs and special events—some general, some interdisciplinary, and still others of interest to specialists—will be such as to bring together scientists from all parts of the continent. Then there are other factors that will contribute to the anticipated attendance. There will be a special meeting of the AAAS-affiliated Colorado-Wyoming Academy of Science. Moreover, the 128th meeting of the Association will also be the 38th annual meeting of the AAAS Southwestern and Rocky Mountain Division. Members of the division have been looking forward to this year's meeting for some time, since it was originally scheduled for 1959 but was postponed for two years because completion of Denver's Hilton Hotel was delayed. The scientific population of the Denver area alone—associated with the large universities, the aviation-missile industry, the Federal Center with its many agencies—is large. Finally, the participating societies, with their national and regional meetings, will bring scientists and teachers in a wide variety of fields. The third Denver meeting will be a particularly significant and memorable scientific congress.

Despite its size, the meeting will be convenient, comfortable, and comparatively inexpensive. The four hotels which will house the approximately 300 sessions—the Denver Hilton, the Brown Palace with its new Annex, the Cosmopolitan, and the Shirley Savoy—are adjacent to the Civic Center and all are across the street, or within a short block or two, from each other. There are many points of interest around the Civic Center, all within walking distance of the four hotels. Among them are the State Capitol with its gold-covered dome, the Colorado State Historical Museum, the Denver Public Library, the Denver Art Museum, and the U.S. Mint, which stores more gold bullion than any other depository outside of Fort Knox. Across the street from the Denver Hilton is the large May–D & F department store, founded in 1864. From this there is both a connecting bridge and an underground passage to the hotel.

Among the societies holding national meetings with the AAAS are the following: American Astronomical Society, American Nature Study Society, American Society of Criminology, American Society of Naturalists, American Society of Zoologists, Beta Beta Beta Biological Society, National Association of Biology Teachers, Scientific Research Society of America, Society for General Systems Research, Society of Protozoologists, Society of Systematic Zoology, and the Society of the Sigma Xi.

Among other societies with special or regional programs of several days' duration are the following: American Association of Clinical Chemists, American Astronautical Society, American Meteorological Society, American Physiological Society, American Psychiatric Association, Association of American Geographers, Ecological Society of America, National Speleological Society, and National Science Teachers Association.

Still other organizations will have conferences or programs—for example, the American Economic Association, the American Sociological Association, the American Statistical Association, the American Political Science Association, the Association for Computing Machinery, the Society for Industrial and Applied Mathematics, the Institute of Management Sciences, Sigma Delta Epsilon, the Conference on Scientific Communication, the Conference on Scientific Manpower, and the Academy Conference, composed of representatives of the 47 state and city academies affiliated with the AAAS.

Special Sessions

The Committee on AAAS Meetings, which has responsibility for the general pattern of the meeting and the details of the general sessions, including the "Moving Frontiers of Science" program, in a joint meeting with the secretaries of the AAAS sections early this year, outlined a particularly attractive series of special sessions and general events. In chronological order, these are as follows.

26 December, evening. Part I of "Moving Frontiers of Science." This program, which consists of lectures by authorities in their respective fields, is planned to be of general interest to all who attend the Denver meeting and to present recent developments in terms intelligible to scientists in other disciplines. All of the sections and many of the participating societies have left these lecture periods open in their schedules.

A fundamental paper on this first

evening of the meeting will be given by Howard A. Meyerhoff, executive director, Scientific Manpower Commission, recently vice president for the Section on Geology and Geography. His subject will be "Changing concepts of mineral raw materials in the national economy." A contrasting paper will be given by Arthur R. von Hippel, director, Laboratory for Insulation Research, Massachusetts Institute of Technology. His topic will be "The molecular designing of materials." The session will be chaired by board member Harrison Brown, professor of geochemistry, California Institute of Technology.

27 December, evening. The 29th John Wesley Powell memorial lecture of the Southwestern and Rocky Mountain Division will be given by Glenn T. Seaborg, chairman, U.S. Atomic Energy Commission, on a topic to be announced.

28 December, morning. Four interdisciplinary symposia in the physical, biological, and social sciences will be presented concurrently. Two of these, as noted, will have additional or complementary sessions on other days. These programs are as follows.

"Physics of the Upper Atmosphere," which will be jointly sponsored by Sections B–Physics and D–Astronomy, cosponsored by the American Geophysical Union, and probably cosponsored by the American Astronomical Society (arranged by Stanley S. Ballard, Florida).

"Geochemical Evolution—the First Five Billion Years" (two sessions, the second to be held the morning of 29 December), sponsored by Section C–Chemistry, cosponsored by Section E–Geology and Geography and the American Geophysical Union (T. S. Lovering, U.S. Geological Survey, Denver). Speakers include G. R. Burbidge (Yerkes Observatory); George Gamow (Colorado); Philip H. Abelson (Carnegie Institution of Washington Geophysical Laboratory); A. E. J. Engel (University of California, La Jolla).

"Existing Levels of Radioactivity in Man and His Environment: Measurement and Significance," sponsored by Section Np–Pharmacy,-cosponsored by Sections F–Zoological Sciences, G–Botanical Sciences, I–Psychology, N–Medical Sciences, Nd–Dentistry, and O–Agriculture (John E. Christian, Purdue). Speakers: Wright H. Langham and Ernest C. Anderson (Los Alamos Scientific Laboratory), P. R. J. Burch (Leeds), Willard F. Libby (University of California, Los Angeles), and K. T. Woodward (Rochester).

"Water and Climate," jointly sponsored by Section O–Agriculture and the Committee on Desert and Arid Zones Research of the Southwestern and Rocky Mountain Division, cosponsored by Sections E–Geology and Geography, K–Social and Economic Sciences, M–Engineering, and P–Industrial Science, and, probably, by the American Meteorological Society and the American Geophysical Union (Terah L. Smiley, Arizona). Speakers will include Walter Orr Roberts (Colorado), John W. Harshbarger (Arizona), Dwight B. Kline (U.S. Weather Bureau), and Frank J. Trelease (Wyoming).

28 December, afternoon. Part II of "Moving Frontiers of Science." There will be two lectures; one, "The evolution of stars and galaxies," will be given by Halton C. Arp (Mt. Wilson and Palomar Observatories).

28 December, evening. Address of the retiring president of the AAAS, Chauncey D. Leake. Announcement will be made of several awards—the Newcomb Cleveland prize for 1960, the Socio-Psychological prize, and the AAAS-Campbell award for vegetable research. After the address there will be a reception for all registrants, with refreshments and cigarettes provided. Alcoholic beverages will be served at a "Dutch treat" bar. The reception thus will include the AAAS Smoker for all registrants.

29 December, evening. Honor Societies Night. The annual joint address of the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa will be given by Harrison Brown (California Institute of Technology). After a brief interval, the annual address of the Tau Beta Pi Association with the AAAS will be given.

30 December, evening. The annual illustrated lecture and film of the National Geographic Society, usually a first showing.

Other General Events

The *AAAS Committee on Science in the Promotion of Human Welfare.* Barry Commoner (Washington University) will arrange one or more sessions.

The *AAAS Cooperative Committee on the Teaching of Science and Mathematics.* John R. Mayor (AAAS) plans to sponsor a symposium on science teaching in grades kindergarten through 9.

The *AAAS Committee on Public Understanding of Science* will have its first public program at the Denver meeting (Edward G. Sherburne, Jr., AAAS).

The *Committee on Desert and Arid Zones Research* of the Southwestern and Rocky Mountain Division [Terah L. Smiley (Arizona), chairman] has arranged a two-session symposium on water improvement, cosponsored by Section O–Agriculture (Joseph A. Schufle, New Mexico Institute of Mining and Technology) (30 Dec.). Subtopics and speakers are as follows: control of pollution, William N. Gahr (Colorado State Department of Public Health), Bernard B. Berger (U.S. Public Health Service, Cincinnati), and Gordon McCallum (U.S. Public Health Service, Washington, D.C.); control of saline water encroachment, Robert E. Glover and Morton W. Bittinger (Colorado State) and David K. Todd (University of California, Berkeley); chemical and physical methods of water improvement, H. P. Gregor (Polytechnic Institute of Brooklyn) and George W. Murphy (Oklahoma); and a summary by Peter C. Duisberg (consultant, El Paso) or John F. Lance (Arizona), or both.

The 10th annual *Conference on Scientific Communication* (George L. Seielstad, Johns Hopkins), following last year's multisession symposium on the sciences in Communist China, will sponsor several sessions on current problems in communication.

The program of the 11th *Conference on Scientific Manpower* (Thomas J. Mills, National Science Foundation), cosponsored by the National Science Foundation, National Research Council, Engineering Manpower Commission, and Scientific Manpower Commission and by Sections M–Engineering and E–Geology and Geography, will be devoted to the manpower outlook in geology and related fields of engineering—a subject of special interest in the Denver area. The earth sciences are fields in which there has been less increase in requirements for scientists and engineers. At the symposium the present situation will be reviewed in terms of training, present employment, and utilization; future prospects in traditional activities such as exploration will be considered; and the possibility of retraining for transfer to closely related fields will be assessed.

The *Academy Conference*, founded in 1927 and composed of the official representatives of the now 47 academies of science affiliated with the AAAS, has had a program at each annual meeting of the Association since the fifth New York meeting of December 1928. At this year's 33rd meeting of the conference there will be a full day of sessions (27 Dec.). At the business meeting in the morning, reports of the individual academies will be distributed rather than read, to provide more time for individual comments and for a general discussion of academy problems. In the afternoon there will be a debate on the subject, "Why Collegiate Academies?" between Clinton L. Baker (Southwestern at Memphis) and Norman D. Levine (Illinois), with E. Ruffin Jones (Florida) presiding. The day will conclude with the annual Academy Conference Dinner and the conference presidential address by Robert C. Miller (California Academy of Sciences, San Francisco), with John G. Arnold, Jr., (Loyola) presiding.

The session on junior academies, sponsored by the Academy Conference, will be held 28 December. The Academy Conference also will sponsor the 15th Annual Junior Scientists Assembly, a program for selected high school students interested in science and scientific careers, which will be arranged this year by Sam S. Blanc, coordinator of instruction, Denver Public Schools.

AAAS Council Meetings

The AAAS Council will hold two sessions, on 27 and 30 December. Because election of the AAAS president-elect and of new members of the Board of Directors is now conducted by mail, more time is available at these sessions than formerly for consideration of matters that affect all science and society. The work of the Council is materially assisted by the Committee on Council Affairs. Other committees and many of the sections will have business meetings.

Science Exhibits

The significance of the third Denver meeting has already been recognized by those who produce the books, instruments, and materials which scientists and teachers use. Applications for exhibit booths at the Denver Hilton Hotel have been received at a most gratifying rate. At this time, seven months in advance of the meeting, only a few booths remain to be assigned.

This year's Annual Exposition of Science and Industry will be one of the most balanced and attractive ever presented. Leading publishers, optical companies, and instrument makers and many suppliers of laboratory materials and equipment will show their latest publications and products. In addition, there will be selected displays of some of the research activities of large industrial firms and exhibits of governmental agencies.

Incidentally, the exposition is *not* intended for young people below the college, or the exceptional high-school senior, level, for most of the exhibits are too technical for younger students of science. (To meet the interests of the latter, the Association's Academy Conference annually arranges a Junior Scientists Assembly, at which eminent scientists address a large audience of high school students on aspects of science and scientific careers.) In the best interests of both exhibitors and those interested in their displays, *only registrants are admitted to the exposition*, and young people (under 16) are not registered.

Science Theatre

The AAAS Science Theatre again will show a choice selection of science films, foreign and domestic, in a special room just off the exposition area. As usual, the theatre will run each film at least twice. Thus, those who are especially interested in a particular film will have more than one opportunity to see it.

Physical Facilities

The completely new Denver Hilton, which has been in operation only since April 1960, will be AAAS Headquarters. This 22-story hotel, on Court Place, is wide from north to south and narrow from east to west, so that all 884 sleeping rooms are "outside" and have impressive views. There are spacious public areas, and there is an excellent range of well-equipped session rooms. Welcome features are the parking area for 1500 cars and the high-speed, self-operated elevators. The Hilton will be the site of the Association's business sessions, the AAAS Pressroom, and the AAAS Office. Its 2B level will house the Annual Exposition of Science and Industry and the AAAS Science Theatre; the special sessions and most of the general events will be held in the large ballroom.

Three other hotels will be the headquarters of related sections and societies: the Brown Palace and the new Brown Palace Tower (connected by a bridge), at 17th Street and Tremont Place, with 600 rooms; the Cosmopolitan, at 18th Street and Broadway, with 425 rooms; and the Shirley Savoy, at 17th Street and Broadway, with 400 rooms. The session rooms of the four hotels will be used intensively. Uniform rates for the Association meeting have been established, as follows: Room with single bed, $8 and $8.50; room with double bed, one occupant, $7.50, $9, and $10; room with double bed, two occupants, $10 and $13; room with twin beds, one occupant, $9 and $10; room with twin beds, two occupants, $12, $14, and $15; and studio type room with twin beds, $15. Sleeping accommodations in other hotels, farther from the Civic Center, will also be available, if needed.

The headquarters of the sections and societies will be announced in *Science* in July, at which time coupons for housing and advance registration will appear among the advertising pages. (To secure the special rates, registrants should use the hotel room coupon, or a reasonably accurate copy of it, and should send it directly to the AAAS Housing Bureau, 225 West Colfax Ave., Denver 2, Colo.) As usual, advance registrants will receive the *General Program* early in December.

Programs. A synopsis of the programs, arranged by disciplines, follows. The names given in parentheses are those of section and society officers or program chairmen.

Mathematics (A)

The program of Section A (Wallace Givens, Northwestern) will include a morning session on digital computers and matrix computation (30 Dec.), in which George E. Forsythe (Stanford) will speak on educational implications of the computer revolution. Another speaker will be Richard Hamming of the Bell Telephone Laboratories. This session will be cosponsored by the *Society for Industrial and Applied Mathematics* (James H. Griesmer, IBM Research Center, Yorktown Heights, N.Y.) and by the *Association for Computing Machinery* (Bruce Gilchrist, IBM Research Laboratory).

In the afternoon (30 Dec.), Section A and the *Committee on the Undergraduate Program in Mathematics* of the Mathematical Association of America will jointly sponsor a program on recommendations for the training

of teachers of mathematics, arranged by Robert J. Wisner (Michigan State). Section A also will jointly sponsor the session of the *Institute of Management Sciences* (Merrill M. Flood, Michigan) on recent mathematical, statistical, and economic developments useful in management science (29 Dec.). Section P will cosponsor this session.

Physics (B)

Section B (Stanley S. Ballard, Florida), with Section D–Astronomy and, probably, the American Astronomical Society, will jointly sponsor the symposium on physics of the upper atmosphere, (28 Dec.), mentioned above under Special Sessions. The American Geophysical Union will be a cosponsor. There will be a specialized two-session symposium on physics research in the Rocky Mountain area (27 Dec.). The annual physicists' luncheon (27 Dec.) will be jointly sponsored by Section B and *Sigma Pi Sigma*, the latter making the arrangements. The address after the luncheon will be given by vice president Henry D. Smyth (Princeton).

The *American Astronautical Society* will hold a regional meeting (probably 27 Dec.)

The *American Meteorological Society* (Kenneth Spengler, AMS) may sponsor a special program of invited and contributed papers. The society will also cosponsor appropriate sessions.

Chemistry (C)

The program of Section C (Essie White Cohn, Denver) begins 27 December with a two-session symposium on extraterrestrial biochemistry and biology (Charles R. Phillips, U.S. Army Biological Laboratories, Fort Detrick, Md.) and, concurrently, a two-session symposium on advances in carbohydrates (Horace S. Isbell, National Bureau of Standards). Speakers at the former include A. G. Wedum (Fort Detrick, Md.), Richard Ehrlick (Armour Research Laboratories, Chicago), Hubertus Strugghold (School of Aviation Medicine, Brooks Air Force Base, Texas), Henry C. Stubbs (Milton Academy), Carl Sagan (California), and Sidney Fox (Florida State).

Horace Isbell will preside over the morning session of the carbohydrate symposium and will give a paper on condensation, cleavage, and rearrangement reactions of carbohydrate materials; other titles and speakers will be as follows: "Pathways of biosynthesis of deoxy hexoses," John H. Pazur (Nebraska), and "Carbon-14- and tritium-labeled carbohydrates," Harriet L. Frush (National Bureau of Standards).

Roy L. Whistler (Purdue) will chair the afternoon session of the carbohydrate symposium and will give a paper on the properties and uses of polysaccharides. Other titles and speakers will be as follows: "Gas chromatography of carbohydrates," Henry W. Kircher (Arizona); "Digestibility of polysaccharides," Theodore E. Friedman (Colorado); and "Action of enzymes on polysaccharides," Dexter French (Iowa State University of Science and Technology).

The interdisciplinary symposium on geochemical evolution (28 Dec.) is described under Special Sessions. The second part of that program, and sessions for submitted papers as well, will be held 29 December. The Colorado section of the *American Chemical Society* (Walter H. Dumke, Colorado School of Mines) will cosponsor the program of Section C and will be hosts of the chemists' mixer.

The *American Association of Clinical Chemists* (Albert E. Sobel, Jewish Hospital of Brooklyn), in its annual meeting with the AAAS, will have a symposium on a topic of current interest, sessions for contributed papers, and a dinner with a speaker.

Astronomy (D)

Section D (Frank Bradshaw Wood, Pennsylvania) will cosponsor all sessions of the American Astronomical Society and Section B's interdisciplinary symposium on physics of the upper atmosphere. The vice-presidential address will be given by N. U. Mayall (Lick Observatory), with Robert M. Petrie (Dominion Astrophysical Observatory, Royal Oak, British Columbia) presiding (27 Dec.).

The national meeting of the *American Astronomical Society* will begin with a Council meeting the evening of 26 December and will continue through the afternoon of 30 December. On 27 December there will be two sessions for contributed papers, one of these following Section D's vice-presidential address. The astronomers' dinner will be on 28 December, and on 29 December there will be a session for contributed papers and a symposium on magnetic fields in the solar system, arranged by R. Grant Athay (High Altitude Observatory). On 30 December there will be two additional sessions for contributed papers. Other events include a second Council meeting, the Helen B. Warner lecture by a distinguished astronomer, and a visit to the Chamberlain Observatory. As before, there will be special joint AAAS-AAS convention badges.

The *Astronomical League* (Armand Spitz, Spitz Laboratories, Yorklyn, Del.) will probably have a session early in the meeting period.

Geology and Geography (E)

The program of Section E (Richard H. Mahard, Denison) (26–30 Dec.) includes at least three symposia sessions, sessions for contributed papers, and cosponsorship of other programs, notably the symposium of Section O–Agriculture on land and water use, the interdisciplinary symposium on geochemical evolution, the session of the Conference on Scientific Manpower, and the program of the Association of American Geographers. The two-session symposium on ground-water geology (26 and 27 Dec.) is being arranged by Theodore Walker (Colorado); there will be a session for invited papers entitled "Colorado Plateau stratigraphic studies," on 27 December.

William C. Krumbein (Northwestern) will deliver the vice-presidential address on 27 December, at a dinner for Section E. All geological sessions will be cosponsored by the *Geological Society of America.*

The *Association of American Geographers, Great Plains-Rocky Mountain Division* (M. John Loeffler, Colorado) plans three sessions of invited papers on the population explosion of the western United States. Geographers with special knowledge of the problems of population distribution, space and land utilization, and use and development of resources will participate. A fourth session, one for contributed papers, is also planned. The Association will cosponsor Section O's symposium on land and water use. There will be a geographers' dinner on 29 December.

The *National Speleological Society* (William R. Halliday, 1117 36th Ave. East, Seattle, Wash.) will have two sessions, probably on 27 December.

The *National Geographic Society* will present its usual outstanding lecture and film on 30 December.

Zoological Sciences (F)

The program of Section F (George W. Wharton, Maryland) will be coordinated with the national meetings of the American Society of Zoologists,

the Society of Protozoologists, and the Society of Systematic Zoology. In view of the many sessions of these societies, Section F's program will be restricted to cosponsorship of appropriate symposia and other sessions, joint sponsorship of the zoologists' dinner, and the vice-presidential address of Jack Schultz (University of California, Berkeley). The section's business meeting will immediately follow that of the American Society of Zoologists. Among the symposia cosponsored will be the four sessions of Section N–Medical Sciences, on physiological and biochemical aspects of human genetics.

The tentative program of the national meeting of the *American Society of Zoologists* (Ray L. Watterson, Northwestern), with more than 30 sessions (28–30 Dec.), includes 21 or more sessions for contributed papers, sponsored by all six divisions of the Society, throughout the meeting period; business meetings of five divisions; the annual business meeting of the ASZ as a whole; and a series of symposia. Subjects and speakers at the symposia are as follows: "cellular endocrinology" (Division of Comparative Endocrinology) (28 Dec.); "Neurosecretion" (Divisions of Comparative Endocrinology and Comparative Physiology) (29 Dec.); "Evolutionary changes in the hormonal and neural bases of reproductive behavior" [William C. Young (Kansas), for the Division of Animal Behavior and Sociobiology] (30 Dec.); "Animal locomotion" [D. Dwight Davis (Chicago Natural History Museum), Harvey I. Fisher (Southern Illinois), and Howard Evans (Cornell), for the Division of Vertebrate Morphology] (30 Dec.). The zoologists' dinner, the vice-presidential address of Section F, and, probably, a smoker for biologists are planned for 29 December.

The 14th annual national meeting of the *Society of Protozoologists* (Norman D. Levine, Illinois) includes some six sessions for contributed papers (27–30 Dec.) and a round-table symposium, "Biochemical phyletic markers among the Protozoa," arranged by Seymour H. Hutner (Haskins Laboratories). The annual luncheon and business meeting will be held 29 December.

The *Society of Systematic Zoology* (Charles F. Lytle, Tulane) will hold its 13th annual meeting with the AAAS. The program will include sessions for contributed papers (30 Dec.), meetings of the council, the annual breakfast and business meeting (30 Dec.), a three-session symposium on "The data of classification" (R. E. Blackwelder, Southern Illinois) (27, 28 Dec.), and a second symposium, on "The biogeography of the Philippine Islands." The annual SSZ library and book lounge for all zoologists will be open 27–29 December.

Biological Sciences (FG)

A major feature of the annual national meeting of the *American Society of Naturalists* (Ernst W. Caspari, Rochester) will be the presidential address of Marston Bates, "Man's ecological niche," to be given the morning of 27 December. The business meeting of the society will follow.

The biennial meeting of *Beta Beta Beta Biological Society* (Mrs. Frank G. Brooks, Box 515, Ansonia Station, New York 23, N.Y.), will be held the morning of 27 December; it will be followed by the biennial luncheon and address (H. P. Sturdivant, Western Maryland).

The *Biometric Society*, Western North American Region (Walter A. Becker, Washington State) has recently made plans to participate in the Denver meeting.

The program of the *Ecological Society of America* (Richard S. Miller, University of Saskatchewan) will begin 26 December with a two-session symposium and will continue (27 and 28 Dec.) with other symposia and some six sessions for contributed papers on plant ecology, animal ecology, human ecology, and aquatic ecology, and a series of sessions jointly sponsored by the Section on Animal Behavior and Sociobiology and with the Division of Animal Behavior and Sociobiology of the American Society of Zoologists, arranged by Martin W. Schein (Penn. State). The Society will also sponsor the Human Ecologists' luncheon (27 Dec.).

The *Mountain Lake Biological Station* (Horton H. Hobbs, Jr., Virginia) again will sponsor an annual breakfast with the AAAS for all persons who have been students, investigators, or staff members at the station since its founding in 1929.

The annual national meeting of the *National Association of Biology Teachers* (Muriel Beuschlein, Chicago Teachers College) will begin with business meetings on 26 December. During the meeting period there will be a joint meeting (27 Dec.) with the American Nature Study Society, the National Association for Research in Science Teaching, and the National Science Teachers Association; the annual NABT presidential address and luncheon (28 Dec.); and a series of separate sessions (27, 29, and 30 Dec.) with the theme "Accent on investigation." A joint session with ANSS on international conservation will be held 28 December and there will be a joint field trip on 29 December.

As it did in New York, the *Nature Conservancy* will hold a meeting of its National Committee for Natural Areas for Schools; arrangements will be made by John W. Brainerd (Springfield College).

Botanical Sciences (G)

Section G (Harriet B. Creighton, Wellesley) plans to inaugurate a series of sessions for invited papers on basic topics for biology teachers, to keep them informed on recent advances. The Section will cosponsor the sessions on plant ecology of the Ecological Society of America and will have sessions for contributed papers in other fields of botany. James F. Bonner will deliver the vice-presidential address of the section at the botanists' luncheon (27 Dec.).

Anthropology (H)

The program of Section H (David M. Pendergast, Utah) will begin with a cocktail party at the Denver Museum of Natural History (27 Dec.). There will be symposia on civilization in desert lands (28 Dec.); on early man in the western United States and on the concept of race (29 Dec.); on applied anthropology (30 Dec.); and on the interdependence of archeology and ethnology (30 Dec.). There will also be sessions for contributed papers (30 Dec.). The banquet of Section H, at the Japanese Roof Garden of the Petroleum Club, at which Jesse D. Jennings (Utah) will give the vice-presidential address, will be held 29 December.

Psychology (I)

Section I (Frank W. Finger, Virginia) has scheduled the vice-presidential address of Carl Pfaffmann (Brown) for 29 December. There will be three symposia (29 and 30 Dec.) as follows: "Sensory factors in food acceptance and appetite," arranged by Carl Pfaffmann; "Aspects of sleep," arranged by W. B. Webb (Florida); and "Control of verbal behavior," arranged by Israel Goldiamond (Arizona State). Contrib-

uted papers relevant to the symposium topics are solicited; abstracts should reach Dr. Finger *by 1 July*.

Social and Economic Sciences (K)

Section K (Donald P. Ray, National Institute of Social and Behavioral Science), with the *American Statistical Association* and the *National Institute of Social and Behavioral Science* as cosponsors, will hold a symposium (27 Dec.) on current problems in social-behavioral research. Frederick F. Stephan (Princeton) will give the vice-presidential address, on social statistics and the prediction of human behavior.

In addition, Section K will sponsor a session for contributed papers in the social and economic sciences (30 Dec.) and will cosponsor appropriate programs of the K series. The program of the Institute of Management Sciences, cosponsored by Section P and joint with Section A, on recent mathematical, statistical, and economic developments useful in management science (29 Dec.) will be of interest to the Section. These programs have been arranged so that no sessions are concurrent except the last.

The *American Economic Association* (Kenneth E. Boulding, Michigan) will have a program of invited papers, cosponsored by Section K (26 Dec.). This is scheduled early so that AEA members may attend both the AAAS meeting and their national meeting, to be held 27–29 December in New York.

The *American Political Science Association* (Evron M. Kirkpatrick, APSA) will have a special program (27 Dec.) cosponsored by Section K.

The program of the *American Society of Criminology* (Donal E. J. MacNamara, New York Institute of Criminology) begins on 29 December with sessions on problems in rural crime control (Gordon Barker, Colorado) and on experimentation and research in criminology. Other sessions (30 Dec.) will be on "Twentieth-century policing" and on "The criminal law and criminal courts." The annual awards of the Society will be made the evening of 29 December; the presentation will be followed by the business meeting. The annual luncheon and address will be held 30 December.

The *American Sociological Association* (Robert Bierstedt, New York University) will have two symposia (28 and 29 Dec.), cosponsored by Section K and the *Population Association of America*.

The *American Statistical Association* (Harold A. Morse, Colorado–Wyoming Chapter, ASA, Denver) will have two sessions (29 and 30 Dec.) of particular interest to local statisticians, cosponsored by Section K.

Details of the programs of the *Metric Association* (Fred J. Helgren, Abbott Laboratories, North Chicago) and of the *National Academy of Economics and Political Science* (Emmet B. Mittlebeeler, American University) will be announced later.

History and Philosophy of Science (L)

The program of Section L (John W. Streeter, 1700 Walnut St., Philadelphia) (26–30 Dec.) will include sessions in the two areas of interest of its members. In the absence of the History of Science Society, which meets biennially with the AAAS, the emphasis, as in 1959, will be on philosophy, but there will be a symposium, "The history of the mining of uranium," cosponsored by the *Society for the History of Technology*, and another, "The Colorado River in history," both arranged by Streeter.

Section L will have eight sessions, arranged by Norwood Russell Hanson (Indiana University), beginning 26 December and extending over the meeting period; the exact dates have not as yet been determined and some adjustments may be made in this program. Dr. Hanson will preside at Session I, "Empiricism and the Status of Theories." Paul K. Feyerabend (University of California, Berkeley) will speak on how to be a good empiricist; discussants will be Wilfrid Sellars (Yale), George T. McClure (Southern Illinois), and Grover Maxwell (Minnesota). Henry A. Finch will speak on theoretical fruitfulness as a measure of concepts; discussants will include Ernest W. Adams (University of California, Berkeley) and Robert Sternfeld (State University of New York).

Dr. Sternfeld will preside at Session II, "History and Philosophy of Science." A paper on the interdependence of history of science and philosophy of science will be read. Giorgio de Santillana (Massachusetts Institute of Technology), Edward Grant (Indiana University), and Gerald Holton (Harvard) are expected to participate in this program. Nicholas Rescher (Pittsburgh) will speak on ethical problems within science; there will be several discussants.

David Hawkins (Colorado) will preside at Session III, "Conventionalism and Laws within Modern Physics." A. E. Woodruff (Chicago) will speak on philosophical aspects of the laws of quantum field theory; one of the discussants will be Hilary Putnam (Princeton). Michael S. Watanabe (IBM Research Center) will deliver a major paper on quantum theory within this session. Gerald Holton will speak on historical aspects of special relativity; it is expected that Joseph Epstein (Amherst College) and Richard A. Mould (State University of New York) will be among the discussants.

Session IV will be Section L's vice-presidental address, given by Norwood Russell Hanson. He will speak on "Scientists and Logicians: A Confrontation." Herbert Feigl (Minnesota) will preside at Session V, "Machines and Brains." Hilary Putnam will speak on brains and behavior; among the discussants will be Newton Garver (Minnesota). David Hawkins will speak on design for a mind; discussants will be Michael S. Watanabe, Bruce Aune (Oberlin), and Peter Winch (University College of Swansea).

Kenneth Hammond (Colorado) will preside at Session VI, "Methodological Problems of the Social Sciences." Richard Rudner (Michigan State University) will speak on logical problems of sociology; discussants will be Roger Buck (Indiana University) and Grover Maxwell (Minnesota). Herbert Feigl will speak on a phase of the mind, behavior, and neurophysiology. Discussants will be Roger Buck (Indiana University) and Merle Turner (San Diego State College). Roger Buck will speak on reflexive predictions; discussants will be Adolf Grünbaum (Pittsburgh), Grover Maxwell, and Michael Scriven (Indiana University).

Wilfrid Sellars will preside at Session VII, "Causality." Michael Scriven will speak on a workable concept of causation; discussants will be William Dray (Toronto), William Rozeboom (St. Olaf College), and Grover Maxwell. Adolf Grünbaum will preside at Session VIII, "The Nature of Historical Explanation." Alan Donagan (Indiana University) will speak on the present state of Hempel's Thesis; discussants will be Benjamin Nelson (State University of New York) and Nicholas Rescher (Pittsburgh). William Dray will speak on causal judgments in history; among the discussants will be Newton Garver.

The second George Sarton memorial lecture, sponsored by the George Sarton Memorial Foundation, the History

of Science Society, and Section L, probably will be given at the end of one of Section L's afternoon sessions.

The *Society for General Systems Research* (G. M. Weinberg, IBM Systems Research Institute, New York) will have a symposium on "The teaching and learning of systems thinking" and a second session, for contributed papers (29 Dec.).

Engineering (M)

The program of Section M (Clarence E. Davies, United Engineering Center Project, New York) will include one or more sessions on pressing engineering problems of the Rocky Mountain region. Section M will cosponsor the program of the Conference on Scientific Manpower and the interdisciplinary symposium on water and climate mentioned under Special Sessions.

The *Tau Beta Pi Association* (Robert H. Nagel, Tennessee) will sponsor an address of general interest by a prominent engineer or scientist (29 Dec.).

Medical Sciences (N)

As in previous years, Section N will have a four-session symposium (29–30 Dec.) with participants coming from all parts of the country. Invitations to deliver talks have also been extended to two British scientists. This year's subject is physiological and biochemical aspects of human genetics. The symposium is being organized by Alexander G. Bearn (Rockefeller Institute) with the collaboration of the secretary of Section N. The papers will deal with basic aspects of molecular biology (genes and DNA, and gene-enzyme relationships) as well as with specific metabolic abnormalities, immunochemistry, and broader genetic and medical implications. John B. Youmans (American Medical Association) will give the vice-presidential address, and the winner of the 17th Theobald Smith award, given by Eli Lilly and Company, will be announced. Section N will also cosponsor appropriate programs, such as Section Nd's complemental program on dental genetics.

The annual symposium of *Alpha Epsilon Delta* (Maurice L. Moore, national secretary), on career opportunities in medicine and dentistry, will be held 28 December and will be followed by the annual luncheon and luncheon address, and by a tour of local medical facilities.

The *American Physiological Society* (Robert E. Smith, University of California Medical Center) is planning a program on space physiology, probably to be cosponsored by the American Astronautical Society. The most recent developments in this fast-moving field will be presented.

The *American Psychiatric Association, Committee on Research* (Milton Greenblatt, 74 Fenwood Rd., Boston) will sponsor its customary four-session program with the AAAS. No details are as yet available.

Dentistry (Nd)

Section Nd (Albert A. Dahlberg, Chicago) will have a two-session symposium on dental genetics (27 Dec.), with a luncheon between the morning and afternoon sessions. The program of the section will be cosponsored by Section N–Medical Sciences and by the *American College of Dentists*, the *American Dental Association*, and the *International Association for Dental Research, North American Division*.

Pharmacy (Np)

The three-day program of Section Np (John E. Christian, Purdue) includes two sessions for contributed papers in hospital pharmacy (27 Dec.); the interdisciplinary symposium on existing levels of radioactivity in man and his environment, already discussed under Special Sessions (28 Dec.); and two sessions for contributed papers (29 Dec.). The section's luncheon, with vice-presidential address by Joseph A. Oddis (American Pharmaceutical Association, Washington), and also a sectional dinner will be held 28 December.

Section Np's entire program will be cosponsored by the *American Association of Colleges of Pharmacy*, the *American College of Apothecaries*, the *American Society of Hospital Pharmacists*, the *American Pharmaceutical Association, Scientific Section*, and the *National Association of Boards of Pharmacy*.

Agriculture (O)

Section O (D. Wynne Thorne, Utah Agricultural Experiment Station) will have a four-session symposium on "Land and water use with special reference to mountain and plains regions" (27 and 29 Dec.). The program will be cosponsored by Section E–Geology and Geography and by the Committee on Desert and Arid Zones of the Southwestern and Rocky Mountain Division.

Part I of this symposium (27 Dec., morning) will be on land and water resources. Titles and speakers are: "Population demands for land and water resources of the western hinterland," Stephen C. Smith (University of California, Berkeley); "Land resources and potential uses (quality, patterns of ownership, use suitability)," R. D. Hockensmith (Soil Conservation Service); "Water resources, development, and uses," William Palmer (Bureau of Reclamation, Washington); and "Public grazing lands in the economy of the West," M. L. Upchurch (USDA, Washington).

Part II (27 Dec., afternoon) will be on optimum uses for resources. Titles and speakers are: "Criteria and planning for optimum use," Emery Castle (Oregon State); "Economic priorities on water use in arid regions (economic returns from various uses of water in arid regions)," Nathaniel Wollman (New Mexico); "Recreational resources of the West and their development (gauging the demand for recreational resources)," Laurence I. Hewes, Jr. (National Outdoor Recreation Resources Review Committee, Washington); and "Recreation as a competitive segment of multiple use," Marion Clawson (Resources for the Future, New York City).

Part III (29 Dec., morning) will be on impact of public policy on land and water use. Titles and speakers are: "The government's responsibility for land and water (guardian or developer)," Luna B. Leopold and Raymond L. Nace (U.S. Geological Survey, Washington); "Problems and policies associated with wilderness areas and other reserves of public lands," C. R. Gutermuth (Wildlife Management Institute, Washington); "Problems growing out of the spaciousness of the West," Morris Kelso (Arizona); and "Public and/or private investment in resource development," William Folz (Idaho).

Part IV (29 Dec., afternoon) will be on projecting management programs. Titles and speakers are: "Providing for multiple use in managing land and water," John Hopkin (Bank of America, San Francisco); "Modifying management and vegetation of watershed areas for improved water yields," Fred Kennedy (Regional Forester, Albuquerque, N.M.); "Management associated with complex use for wildlife, livestock, and recreation," A. L. McComb (Arizona); and "Managing private lands in relation to changing uses of public lands," Norman Keith Roberts (Utah State University).

Section O is a joint sponsor of the interdisciplinary symposium on water and climate, described under Special

Sessions, and a cosponsor of the two-session symposium on water improvement.

Industrial Science (P)

Section P (Allen T. Bonnell, Drexel Institute) is planning a symposium on communications and will cosponsor the joint symposium on water and climate. It will also cosponsor the symposium on management science of the Institute of Management Sciences. J. A. Hutcheson (Westinghouse Electric Corp.) will give the address of the retiring vice president at the annual luncheon. The Section will also give the sixth Industrial Citation Dinner.

The *Institute of Management Sciences* (Merrill M. Flood, Mental Health Research Institute, Ann Arbor, Mich.) will have a symposium on management science, cosponsored by Section P (29 Dec.). This session, to be held jointly with Section A–Mathematics, will be devoted to recent mathematical, statistical, and economic developments useful in management science.

Education (Q)

The program of Section Q (Herbert A. Smith, Kansas) includes two joint sessions with the *Council for Exceptional Children* (26 Dec.); two joint sessions with the *American Educational Research Association* (30 Dec.), one of which may be a symposium on teaching machines; some five sessions for contributed papers (27, 29, and 30 Dec.); a business meeting; and the vice-presidential address of William H. Bristow (New York City Board of Education).

The four science teaching societies (ANSS, NABT, NARST, and NSTA), meeting with the AAAS (coordinator, Sam S. Blanc, Denver City Schools), will have a joint session (27 Dec.) and a series of concurrent sessions similar to the coordinated programs of recent years. A joint coffee hour and mixer will be held 27 December at 5 P.M.

The national annual meeting of the *American Nature Study Society* (S. Glidden Baldwin, Danville, Ill.) will begin with a board meeting (26 Dec.). After the joint session of all science teaching societies (27 Dec.) there will be a session on "Nature study around the world," Richard L. Weaver presiding. On 28 December there will be a session on "Outdoor nature interpretation" and a joint program with NABT on "Resource conservation around the world." On 29 December, there will be a joint field trip with NABT; the business meeting; and the annual banquet,

with a motion-picture film, *Nature Adventure around the World*. There will be sessions (30 Dec.) on "Ecology and natural history of the Rocky Mountains," Ruth Hopson, presiding, and a special meeting at the Denver Natural History Museum, Alfred M. Bailey, presiding.

The *Colorado Science Teachers Association* (Joseph E. Pierce, Durango, Colo.) will sponsor a luncheon on 30 December.

The annual national meeting of the *National Association of Biology Teachers* was discussed earlier, under Biological Sciences.

The *National Association for Research in Science Teaching* (George G. Mallinson, Western Michigan) will probably have a research symposium.

After the joint meeting of the science teaching societies, a regional meeting of the *National Science Teachers Association* (Marjorie Gardner, NSTA, Washington, D.C.) will be held. This will consist of four sessions, one the afternoon of 27 December, and three morning sessions 28–30 December. On 30 December, the Colorado Science Teachers Association, a chapter of the National Science Teachers Association, will hold a luncheon session.

Science Service (Leslie V. Watkins, Science Service) will sponsor a session on "Extracurricular motivation for science" (29 Dec.).

Science in General (X)

A number of organizations, too general in their interests to be placed in any sectional series or under any specific discipline, will constitute the "X series" in the printed *General Program*. In this preliminary synopsis of the third Denver meeting, the programs of many of these—the Academy Conference, the Conference on Scientific Communication, and the Conference on Scientific Manpower—have already been mentioned under Other General Events, and thus will not be repeated here.

The *American Geophysical Union* (Waldo Smith, AGU, Washington, D.C.) will cosponsor the interdisciplinary symposia on geochemical evolution and on physics of the upper atmosphere, mentioned under Special Sessions.

The regular annual meeting of the *National Association of Science Writers* (Herbert B. Nichols, U.S. Geological Survey) with the AAAS will include a business session and dinner. A feature of the latter will be the third presentation of the new series of the AAAS-George Westinghouse Science Writing

Awards for excellence in science writing in newspapers and magazines (27 Dec.).

The national convention of the *Scientific Research Society of America* (Donald B. Prentice, Yale) is scheduled for 29 December. The award of the William Procter prize and the annual RESA address will follow the luncheon held jointly with the Society of the Sigma Xi.

A regional meeting of *Sigma Delta Epsilon*, graduate women's scientific fraternity (Ernestine B. Thurman, National Institutes of Health), will include a tea for all women in science. A headquarters room will be maintained throughout the meeting period.

The 62nd annual convention of the *Society of the Sigma Xi* (Thomas T. Holme, Society of the Sigma Xi, New Haven) will be held on 29 December, after the joint luncheon with RESA. In the evening the Society of the Sigma Xi will join with the *United Chapters of Phi Beta Kappa* (Carl Billman, Phi Beta Kappa, Washington, D.C.) in sponsoring the address by Harrison Brown. Since the inauguration of the series in 1922, these distinguished lectures, of interest to all participants, have been a special feature of the Association meeting.

Call for Papers by AAAS Sections

Eight sections of the Association will arrange sessions for contributed papers at the Denver meeting. The secretaries or program chairmen to whom titles and abstracts should be sent, *not later than 30 September*, are as follows:

C–CHEMISTRY. Essie White Cohn, Department of Chemistry, University of Denver, Denver 10, Colo. (by 1 August if possible).

E–GEOLOGY AND GEOGRAPHY. Richard H. Mahard, Department of Geology and Geography, Denison University, Granville, Ohio.

G–BOTANICAL SCIENCES. Harriet B. Creighton, Department of Botany and Bacteriology, Wellesley College, Wellesley 81, Mass.

H–ANTHROPOLOGY. David M. Pendergast, University of Utah, Salt Lake City 12.

I–PSYCHOLOGY (in certain fields only, *by 1 July*; see details under section report). Frank W. Finger, Department of Psychology, University of Virginia, Charlottesville.

K–SOCIAL AND ECONOMIC SCIENCES. Donald P. Ray, National Institute of Social and Behavioral Science, George Washington University, Washington 6, D.C.

NP–PHARMACY. John E. Christian, School of Pharmacy, Purdue University, Lafayette, Ind.

Q–EDUCATION. Herbert A. Smith, Bailey Hall, University of Kansas, Lawrence.

Although the general deadline is 30 September, most sections, and subsequently the AAAS office, would be happy to receive titles in advance of that date.

RAYMOND L. TAYLOR
Associate Administrative Secretary

Forthcoming Events

June

18–23. American Meteorological Soc., 193rd natl., and Pacific Div., AAAS, 42nd annual, Davis, Calif. (AMS, 45 Beacon St., Boston 8, Mass.)

18–23. American Soc. of Medical Technologists, Seattle, Wash. (Miss R. Mathaei, Suite 25, Hermann Professional Bldg., Houston 25, Tex.)

19–21. American Soc. of Pharmacognosy, annual summer meeting, Houston,

Tex. (R. S. Westby, Eli Lilly and Co., 740 S. Alabama St., Indianapolis 6, Ind.)

19–21. Space Flight and Re-entry Trajectories, symp. by Intern. Acad. of Astronautics, Paris, France. (Secretariat, IAA, 12 rue de Gramont, Paris 2)

19–23. Conference on Carbon, 5th biennial, University Park, Pa. (Fifth Carbon Conf., Pennsylvania State Univ., Conference Center, University Park)

19–23. Current Aspects of Internal Medicine, postgraduate course, American College of Physicians, Iowa City, Iowa. (E. C. Rosenow, Jr., Executive Director, ACP, 4200 Pine St., Philadelphia 4, Pa.)

19–24. Feed Microscopy, annual meeting and special short course, Denver, Colo. (C. Jones, Colorado Department of Agriculture, 3130 Zuni St., Denver 11)

19–30. Astrophysics Seminar, Cloudcroft, N.M. (J. R. Foote, P.O. Box 1053, Holloman Air Force Base, N.M.)

21–1. International Plastics Exhibition and Convention, London, England. (British Plastics, Dorset House, Stanford St., London, S.E.1)

22–23. American Rheumatism Assoc., New York, N.Y. (F. E. Demartini, 622 W. 168 St., New York 32)

22–23. Computers and Data Processing, 8th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst., Univ. of Denver, Denver, Colo.)

22–24. Endocrine Soc., New York, N.Y. (H. H. Turner, 1200 N. Walker, Oklahoma City 3, Okla.)

22–26. American College of Chest Physicians, New York, N.Y. (M. Kornfeld, 112 E. Chestnut St., Chicago 11, Ill.)

23–25. American College of Angiology, 7th annual, New York, N.Y. (A. Halpern, Secretary, 11 Hampton Court, Great Neck, N.Y.)

25–28. American Soc. of Agricultural Engineers, annual, Ames, Iowa. (J. L. Butt, 420 Main St., St. Joseph, Mich.)

25–29. Morphological Precursors of Cancer, intern. symp. (by invitation only), Perugia, Italy. (L. Severi, Div. of Cancer Research, Univ. of Perugia, P.O. Box 167, Perugia)

25–30. American Medical Assoc., 110th annual, New York, N.Y. (AMA, 535 N. Dearborn St., Chicago 10, Ill.)

25–30. American Soc. for Testing Materials, Atlantic City, N.J. (R. J. Painter, 1916 Race St., Philadelphia, Pa.)

25–30. International Union of Leather Chemists Societies, 8th congr., Washington, D.C. (F. O'Flaherty, Dept. of Leather Research, Univ. of Cincinnati, Cincinnati 21, Ohio)

25–30. National Education Assoc. of the U.S., Atlantic City, N.J. (W. G. Carr, 1201 16 St., NW, Washington 6)

26–27. Conference on Vacuum Metallurgy, 5th annual conf., New York, N.Y. (R. F. Bunshah, Dept. of Metallurgical Engineering, New York Univ., New York 53)

26–28. American Soc. of Heating, Refrigerating and Air-Conditioning Engineers, 68th annual, Denver, Colo. (J. H. Cansdale, ASHRAE, 234 Fifth Ave., New York 1)

26–28. Control of Noise, symp., Teddington, England. (Director, Natl. Physical Laboratory, Teddington, Middlesex)

26–28. European Symp. on Space Technology, London, England. (Secretary, British Interplanetary Soc., 12 Bessborough Gardens, London, S.W.1)

26–28. Military Electronics, 5th natl. convention, Washington, D.C. (H. Davis, SAFRD, Pentagon, Washington 25)

26–30. American Soc. for Engineering Education, annual, Lexington, Ky. (M. Baker, Univ. of Kentucky, Lexington)

26–30. Concepts and Design in Aerospace Electricity, Philadelphia, Pa. (D. H. Scott, General Electric Co., No. 3, Penn Center Plaza, Philadelphia 2)

26–30. Reading Conf., 3rd annual, Syracuse, N.Y. (R. A. Kress, Syracuse Univ., Syracuse 10)

26–9. Large Dams, 7th intern. congr., Rome, Italy. (U.S. Committee on Large Dams, c/o Engineering Joint Council, 29 W. 39 St., New York 18)

27. Colloid Symp., by Faraday Soc., Glasgow, Scotland, (A. S. Hyde, Chemistry Dept., Royal College of Science and Technology, Glasgow, C.1)

27–29 Analytical Astrodynamics, intern. symp., Santa Barbara, Calif. (Capt. J. L. Gilbert, Air Force Office of Scientific Research, Washington 25)

27–29. Society for Investigative Dermatology, Inc., New York, N.Y. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

27–30. American Home Economics Assoc., Cleveland, Ohio. (Miss M. War-

ren, School of Home Economics, Univ. of Oklahoma, Norman)

27–30. Hurricanes, 2nd technical conf., American Meteorological Soc., Miami Beach, Fla. (AMS, 45 Beacon St., Boston 8, Mass.)

28–30. International Gas Conf., 8th Stockholm, Sweden. (R. H. Touwaide, Union Internationale de l'Industrie du Gaz, 4, avenue Palmerston, Brussels 4)

28–30. Joint Automatic Control Conf., Boulder, Colo. (R. Kramer, Massachusetts Inst. of Technology, Cambridge 39)

28–1. Institute of Navigation, annual, Williamsburg, Va. (C. T. French, General Precision, Inc., 777 14 St., NW, Suite 611, Washington, D.C.)

29–1. American Assoc. of Physics Teachers, Stanford, Calif. (R. P. Winch, Williams College, Williamstown, Mass.)

July

1–3. Astronomical League, Detroit, Mich. (W. A. Cherup, 4 Klopfer St., Millvale, Pittsburgh 9, Pa.)

2–7. American Physical Therapy Assoc., Chicago, Ill. (Miss L. Blair, Executive Director, APTA, 1790 Broadway, New York 19)

2–9. Rural Medicine, 1st intern. congr., Tours, France. (Prof. Vacher, Secretaire General, c/o Institut National de Medecine, Agricole, Ecole de Medecine, Tours)

3–6. Clay Minerals, colloquium on genesis and synthesis of, intern., Paris, France. (Prof. Hocart, Faculté des Sciences, Université de Paris à la Sorbonne, 47 rue des Ecoles, Paris 5)

3–8. Treatment of High Level Radioactive Wastes, symp., Intern. Atomic Energy Agency, Vienna, Austria. (IAEA, 11 Kärtner Ring, Vienna 1)

3–16. Durability of Concrete, symp., Intern. Union of Testing and Research Laboratories for Materials and Structures, Prague, Czechoslovakia. (B. Hacar, Director, Inst. of Theoretical and Applied Mechanics, Czechoslovak Acad. of Sciences, Solínova 7, Prague 6-Dijvice)

4–8. Latin-American Assoc. of Physiological Sciences, 4th meeting, Ribeirão Preto, Brazil. (C. R. Diniz, Caixa Postal 301, Ribeirão Preto, Estado de São Paulo)

5–8. European Organization for Research on Fluorine and Dental Caries Prevention, 8th meeting, London, England. (J. R. Forrest, Senior Dental Officer, Ministry of Health, Savile Rd., London)

5–8. Optical Materials, colloquium, Intern. Commission for Optics, Paris, France. (Institut d'Optique, 3, Boulevard Pasteur, Paris 15)

5–9. International Convention on Radio Techniques and Space Research, Oxford, England. (British Institution of Radio Engineers, 9 Bedford Sq., London, WC.1)

5–12. International Ophthalmic Optical Congr., London, England. (G. H. Giles, Intern. Optical League, 65 Brook St., London, W.1)

6–7. Free Radicals, intern. symp., 5th, Uppsala, Sweden. (Symposium Secretariat, c/o Inst. of Physical Chemistry, Uppsala)

6–12. Agricultural Medicine, 1st intern. congr., Tours, France. (J. Vacher, Institut National de Medecine Agricole, Ecole de Medecine, Tours)

6–12. Ribonucleic Acids and Polyphosphates: Structure, Synthesis and Function, intern. colloquium, Strasbourg, France. (Prof. Ebel, Faculté de Pharmacie, Université de Strasbourg, Strasbourg)

9–14. Bio-Medical Electronics, 4th intern. conf., New York, N.Y. (H. Schwan, Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia 4)

9–15. American Library Assoc., annual conf., Cleveland, Ohio. (D. H. Clift, 50 E. Huron St., Chicago, Ill.)

9–15. International Dental Federation, 49th annual session, Helsinki, Finland. (Office of Secretary General, IDF, 35 Devonshire Place, London, W.1, England)

10. Bibliographical Soc. of America, Cleveland, Ohio. (E. Wolf II, Library Co. of Philadelphia, Broad and Christian Sts., Philadelphia 47, Pa.)

10–14. Institute in Technical and Industrial Communications, 4th annual, Fort Collins, Colo. (Director, Inst. in Technical and Industrial Communications, Colorado State Univ., Fort Collins)

10–14. International Congr. of Dietetics, 3rd, London, England. (Miss D. F. Hollingsworth, British Dietetic Assoc. 251 Brampton Rd., London, SW.3)

10–14. International Diabetes Federation, 4th congr., Geneva, Switzerland. (B. Rilliet, Secretary General, 4 Boulevard des Tranchees, Geneva)

10–14. Optical Instruments and Techniques, conf., London, England. (K. J. Habell, Natl. Physical Laboratory, Teddington, Middlesex, England)

10–20. Plant Exploration and Introduction, technical meeting on, Food and Agriculture Organization of the U.N., Rome, Italy. (Intern. Agency Liaison Branch, Office of the Director General, Viale della Terme di Caracalla, Rome)

10–24. Medical Electronics, 4th intern. conf., New York, N.Y. (L. E. Flory, David Sarnoff Research Center, Princeton, N.J.)

11–25. World Meteorological Organization, 3rd South American session, Rio de Janeiro, Brazil. (WMO, 1 Avenue de la Paix, Geneva, Switzerland)

12–18. Radioactivity in Food and Agriculture, Expert Committee on the Organization of Surveys for FAO, Rome, Italy. (Intern. Agency Liaison Branch, Office of the Director General, Viale della Terme di Caracalla, Rome)

13–14. Data Acquisition and Processing in Biology and Medicine, conf., Rochester, N.Y. (Office of Public Information, Univ. of Rochester, River Campus Station, Rochester 20)

15–18. Life Insurance Medicine, 7th intern. congr., Lisbon, Portugal. (L. de Carvalho Cancella, Secretary, Parede, Portugal)

16–18. British Congr. of Obstetrics and Gynaecology, 16th, Bristol, England. (Secretary, British Congr. of Obstetrics and Gynaecology, University Dept. of Obstetrics, Southmead Hospital, Bristol)

16–22. International Soc. for Clinical and Experimental Hypnosis, Rio de Janeiro, Brazil. (ISCEH, 33 E. 65 St., New York 21)

17–22. Soil Mechanics and Foundation Engineering, 5th intern. conf., Paris, France. (E. Caminade, Secretaire General, 23 rue de Cronstadt, Paris 15)

18–20. Pulmonary Structure and Function, Ciba Foundation Symp. (by invitation only), London, England. (Ciba Foundation, 41 Portland Pl., London, W.1)

18–21. Inorganic Polymers, intern. symp., Nottingham, England. (General Secretary, Chemical Soc., Burlington House, London, W.1, England)

21–22. World Power Conf. (members only), Moscow, U.S.S.R. (Central Office, 201-2 Grand Buildings, Trafalgar Sq., London, W.C.2, England)

23–28. Otolaryngology, 7th intern. congr., Paris, France. (H. Guillon, Secretary General, 6 Avenue Mac-Mahon, Paris 17)

24–28. Nematology Symp., 6th intern., Ghent, Belgium. (J. van den Brande, Soc. of European Nematologists, Rijkslandboushogeschool, Coupure links 235, Ghent)

24–29. Medical Electro-Radiological Societies, Latin Federation of, 5th congr., Paris, France. (C. Proux, Secretary, 9 rue Daru, Paris 8)

24–30. Urology, 12th intern. congr., Rio de Janeiro, Brazil. (J. Silva de Assis, Secretary, P.O. Box 1275, Belo-Horizonte, Brazil)

26. International Commission for the Prevention of Alcoholism, 7th annual meeting, Washington, D.C. (International Headquarters, 6840 Eastern Ave., NW, Washington 12)

26–28. Detection and Assay of Hormones by Immuno-Clinical Means, Ciba Foundation Colloquium (by invitation only), London, England. (Ciba Foundation, 41 Portland Pl., London, W.1)

27–1. Macromolecular Chemistry, intern. symp., Montreal, Canada. (Organizing Committee, P.O. Box 816, Sarnia, Ontario, Canada)

(See issue of 19 May for comprehensive list)

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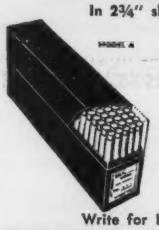

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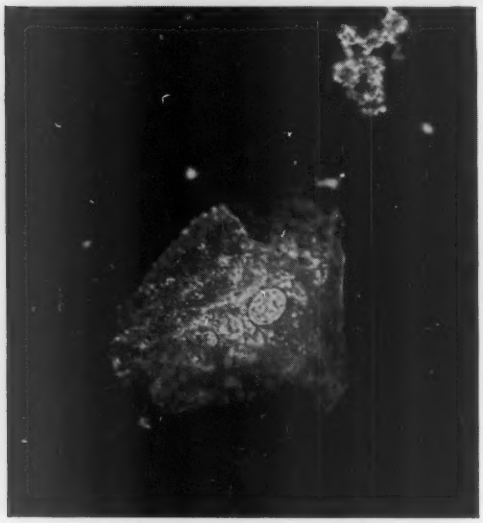

1. First, as shown in the photomicrograph* above, the microscope analyzer was rotated until the background was brought to extinction. Readings were taken directly from the analyzer scale. Averaged settings resulted in reading of 70.4°

2. Next, the analyzer was rotated until the nucleus of the cell was brought to extinction. Averaged settings resulted in reading of 138.2°.

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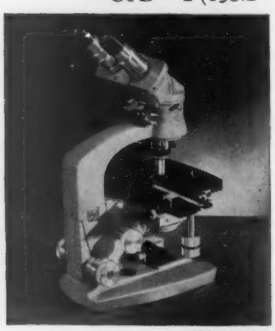

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